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PERIODICITY OF PHYTOPLANKTON OVER TWO SEASONS IN A SHALLOW EUTROPHIC LAKE

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ABSTRACT
Phytoplankton periodicity in Sawley Dene, a shallow eutrophic lake in North Yorkshire, is described over two field seasons (1976–1978). Two main peaks of biomass occurred annually, corresponding with population maxima of the diatom *Asterionella formosa* Hass. in winter/spring and planktonic Cyanophyceae (particularly *Anabaena solitaria* Klebs) in late summer. The periodicity of these and twenty-one other algal species is recorded, together with growth curves for species exceeding five individuals ml^{-1} in the 1976/7 season. Sawley Dene does not exhibit summer thermal stratification but many features of the phytoplankton succession mimic those expected in the epilimnion of a stratifying lake. It is suggested that nutrient stress prevails in this unstratified lake owing to the virtual cessation of lake inflow during the summer months. Autumn replenishment, which in a stratified system would occur with the overturn, takes place in Sawley Dene following increased precipitation on the small catchment area and the resumption of significant water inflow into the lake.

FIGURE 1
Aerial view of Sawley Dene (courtesy of Mr E. E. Binns).

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Introduction

Annual patterns of phytoplankton succession in large lakes have been well documented (see Macan, 1970; Round, 1971, 1981; Fogg, 1975). However, in many parts of Britain, large lakes are outnumbered by small ones less than 10 ha in surface area. While some of these have received attention from limnologists (e.g. Abbot's Pond, Somerset (Moss & Karim, 1969, Hickman, 1974); and the meres of the Shropshire-Cheshire plain (Reynolds, 1973, 1978, 1979)), the majority of such lakes remains uninvestigated and the phytoplankton populations that they might contain at any given time of year are frequently difficult to predict since short retention times, reduced areas of open water and increased susceptibility to small-scale environmental fluctuations combine to reduce ecological stability compared with larger lakes.

Sawley Dene is a relatively small (9.5 ha) lake in North Yorkshire in which a regular seasonal succession of rich and varied algal populations was observed over several years. Certain species in the Sawley Dene plankton have been the subject of detailed cytological investigations, the results of which are being published separately (e.g. Rees & Leedale, 1980; Rees, Donaldson & Leedale, 1980; Cmiech, Reynolds & Leedale, 1984; Cmiech, Leedale & Reynolds, 1984), and a forthcoming series of papers will describe the ultrastructural changes accompanying seasonal development of planktonic Cyanophyceae in the lake. The present paper provides a brief ecological background to these studies and places Sawley Dene in its wider ecological and geographical context.

The Study Site

Sawley Dene (Nat. Grid Ref. SE/263667) is an artificial lake formed by the damming of a steep-sided valley lying at an altitude of 113 m above sea level, approximately 7 km SW of Ripon and 1.5 km SE of Sawley in North Yorkshire (Fig 1). Rivers no longer flow through the valley but in Pleistocene times it is believed to have formed part of a major southward-flowing drainage system together with a number of other unexpectedly deep channels in the area (Fig 2; see Johnson, 1974).

Morphometric data for Sawley Dene are given in Table 1. Figs 3 and 4 show its topographic position and surface features. The main (southwestern) basin only was sampled for this study, the isolated smaller basin being very shallow and therefore unsuitable for the development of 'open-water' plankton communities.

TABLE 1
Morphometric data for Sawley Dene

	whole lake	main basin
surface elevation	113 m	
overall length (inflow-outflow)	650 m	525 m
width (maximum)	195 m	
surface area	9.48 ha	8.46 ha
lake volume	$19.3 \times 10^4 m^3$	$18.3 \times 10^4 m^3$
maximum depth		4.6 m
mean depth		2.2 m
catchment area (water surface included)	0.784 km^2	
theoretical retention time (Rees, 1979)	198 days	

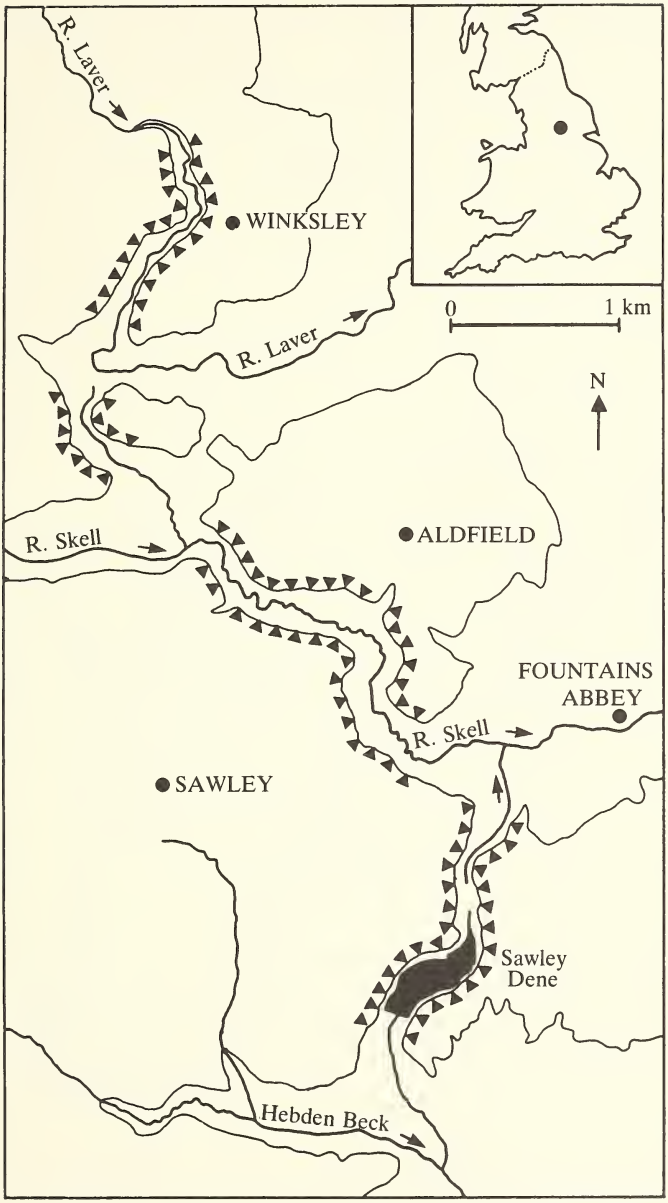

FIGURE 2

Drainage and topography in the Sawley region (inset: location map). Continuous line shows the 122 m contour; arrowheads indicate incised valleys representing an older, north-south drainage pattern.

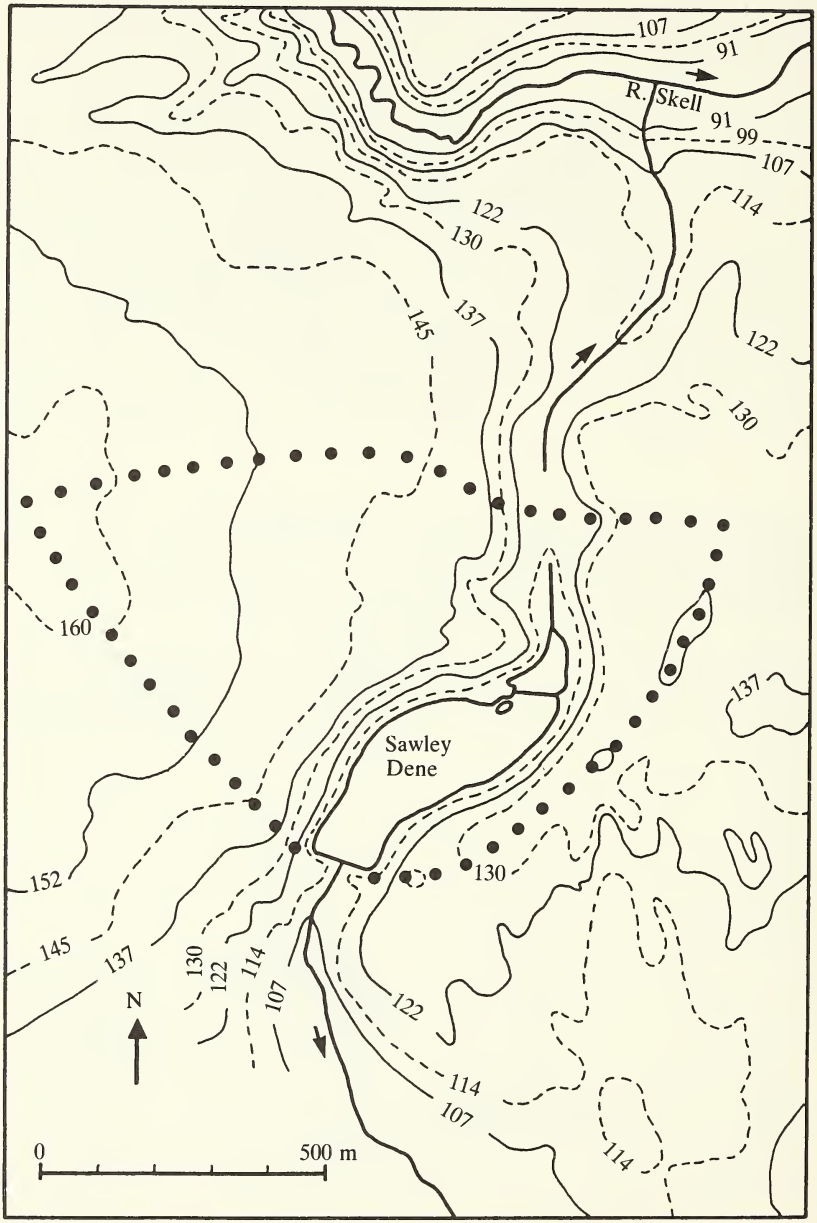

FIGURE 3
Topographic position of Sawley Dene; contours shown at 7.6 m intervals. Closed circles indicate inferred limits of catchment area.

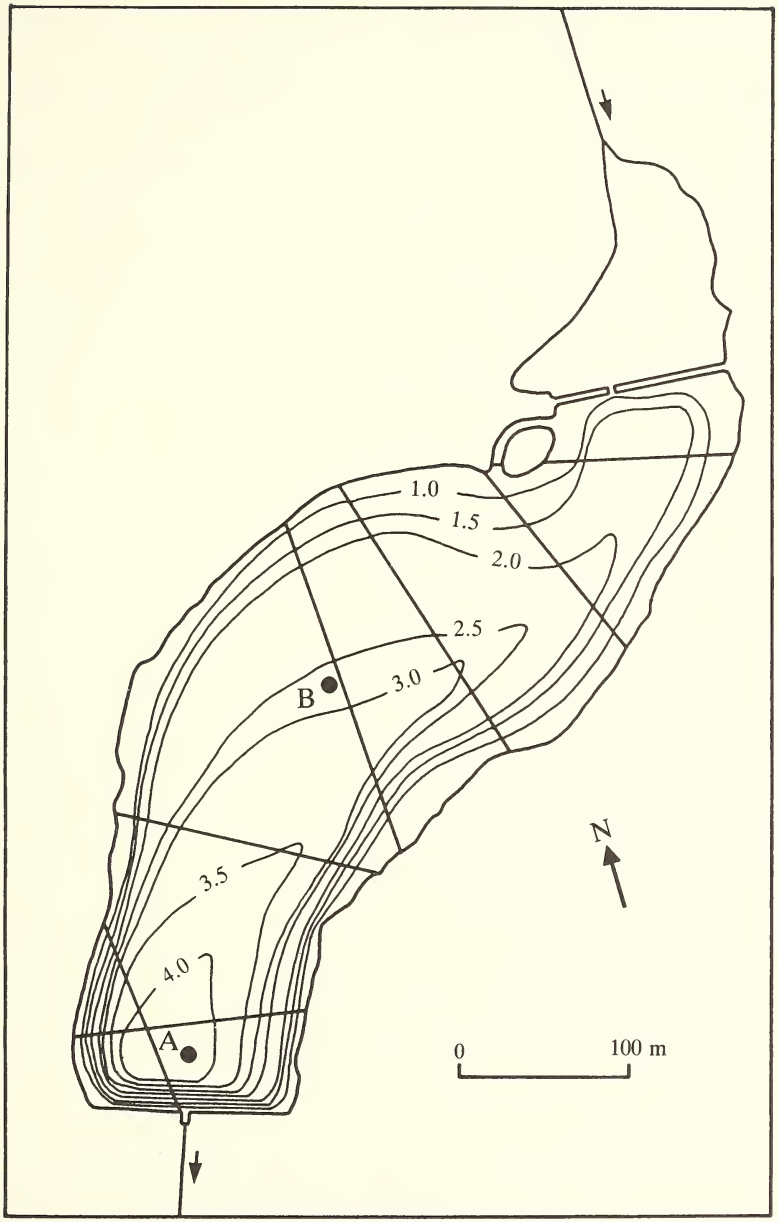

FIGURE 4
Sawley Dene: bathymetry, based on survey by authors, February-March 1976. Straight lines indicate transects used during survey. A, B : sample stations. Depths given in metres.

The water of Sawley Dene is alkaline, moderately ion-rich (Table 2) and in general reflects the chemical nature of the calcareous glacial drift that overlies the millstone grit in this region of the eastern Pennines (see Fox-Strangways, 1908; Edwards, 1938). The lake catchment area is limited (Fig 3) and the chemical richness of the water can be attributed to slow percolation and lateral seepage of groundwater through soluble drift minerals rather than to artifical sources of enrichment, since there are no appreciable human habitations or areas of arable farming in the catchment. The relatively high sulphate level appears to be a local characteristic; sulphur springs occur elsewhere in the vicinity, notably at Aldfield in the valley of the Skell (Fig 2).

TABLE 2

Sawley Dene: Chemical analyses of surface water (all values in meq. l^{-1})

	30.4.76	4.11.76
Cations		
Ca^{2+}	1.950	1.935
Mg^{2+}	0.831	0.722
Na^{+}	0.643	0.652
K^{+}	0.060	0.069
Anions		
HCO_3^{-}	1.498	1.460
SO_4^{2}	1.282	1.222
Cl^{-}	0.765	0.753
pH	7.6–8.2	

Rees (1979) has estimated the theoretical retention time of Sawley Dene (mean residence time of water in the lake) as 198 days (6.5 months), based upon measured annual evaporation over turf and open water in this area (Smith, 1964; Lockwood & Venkatasawmy, 1975), values for surface area and volume of water in the lake (Table 1), mean annual precipitation and size of the catchment area. This retention time is unusually long for a small shallow lake; for comparison, the average replacement time for Blelham Tarn in the English Lake District (total volume 693,000 m^3, surface area 10.2 ha, Lack & Lund, 1974) is only 1.5 months (Lund, 1971) and corresponding values for Windermere North and South Basins and Esthwaite Water (calculated from outflow-level discharge data) are approximately 5, 2.5 and 2.5 months respectively (Talling, 1971). However, the generally small and shallow meres of the Shropshire-Cheshire plain have even longer retention times than Sawley Dene (1-6 years, Reynolds, 1976), owing to their relative hydrological isolation.

Sawley Dene is at present privately maintained as a fishing lake and is stocked annually with 500 brown and rainbow trout. The lake was chosen as a site for biological investigations because large blooms of algae have been known to occur every summer for many years.

Materials and Methods

Routine samples were taken at two stations in the lake (Fig 4), Station A offering the greatest depth of water although being close to the dam and outflow, Station B representing a more open-water situation. Sampling took place from a rowing boat between 1100 h and 1200 h at intervals of 1-2 weeks in summer or 2-4 weeks in winter. All samples were transported to the laboratory within 1–2 h of collection. Temperature and dissolved oxygen concentration were measured *in situ* using a Mackereth probe (Mackereth, 1964). The limit of light penetration at each station was estimated using a Secchi disc. Vertical tube samples of the water column were taken at a depth of 2 m (Station B) or 4.5 m (Station A) with a weighted polythene hose. Net

samples of surface plankton were also collected in the vicinity of Station B using a plankton net of 10 μm nominal mesh size.

Chlorophyll estimations, nitrate and phosphate analyses, and enumeration of plankton populations were carried out in the laboratory. The chlorophyll *a* content of one litre aliquots of the integrated tube samples was estimated by the method of Talling (1974), following concentration of the phytoplankton on Whatman GF/C filters and extraction of pigments in 90 per cent acetone for 1 h Nitrate-nitrogen (NO_3–N) and soluble reactive phosphorus (SRP) were determined for filtered lake water following the procedures of Stainton (1974) and A.D.A.S. (1973), modified for use with a Pye-Unicam AC60 Chemical Processing Unit. Enumeration of populations was made using aliquots of tube samples which were concentrated by centrifugation where necessary, sedimented with Lugol's iodine and assessed using Utermöhl's inverted microscope technique (Lund, Kipling & LeCren, 1958). Results are expressed as the number of individuals (cells, filaments or colonies) ml^{-1} of original (unconcentrated) sample. Separate samples collected by plankton net were assessed semi-quantitatively for species abundance on a logarithmic scale of 1–4, each category representing relative abundance increased by a factor of 10. These semi-quantitative records extend over the whole period of study while more intensive sampling was undertaken only during the 1976/7 field season.

Results

Surface temperatures at the times of sampling ranged from 24°C in summer to periods of ice cover for up to seven weeks in winter (Fig 5a). Temperature-depth profiles from Stations A and B over the period May-October 1976 are given in Cmiech (1981). These show occasional temperature gradients of up to 2°C in the water column following periods of rapid surface heating but absence of persistent summer thermal stratification. Similarly, low concentrations of dissolved oxygen (i.e. below 20 per cent saturation) occurred only occasionally towards the bottom of the water column following unusually warm calm conditions.

Fluctuations in rainfall (Fig 5b) were not measured on site but records for the relevant period from a gauge at Lumley Moor Reservoir (SE/223708), 5 km north-west of Sawley Dene, have been supplied by the Meteorological Office, Bracknell. A rainfall map of the area, consulted at the Harrogate office of the Ministry of Agriculture, Fisheries and Food, shows mean annual precipitation at Sawley Dene to be 825 mm; the gauge at Lumley Moor Reservoir, with a mean annual precipitation of 911 mm, will give values approximately 10 per cent higher than those expected at Sawley. Nevertheless, monthly variations will be essentially the same and can be considered to apply equally to precipitation in the Sawley Dene catchment area. Noteworthy features of these variations include a prolonged dry period in summer 1976 followed by two months of exceptionally heavy rainfall, and a pattern much closer to long-term means in 1977. In each of the two summers under study, water inflow to the lake declined periodically to such an extent that the water level fell below that of the outflow and effective throughput of water ceased (Fig 5b).

Levels of nitrate-nitrogen in surface water samples taken over the 1977/8 field season showed a steady decrease throughout spring and early summer with low levels of less than 0.2 mg l^{-1} occurring in the summer period, followed by an autumn rise coinciding with increased rainfall (Fig 5c). Maximum values of 2.1–2.2 mg l^{-1} NO_3–N were recorded in January and February 1978. Samples analysed for soluble reactive phosphorus (SRP) over the same period consistently yielded negative results, suggesting that levels were below the limit of detection of the method employed (10 μg l^{-1} SRP).

Chlorophyll *a* levels were monitored at Stations A and B from June 1976 to April 1977 and showed peak values of 25–38 μg l^{-1} in August-September with a subsidiary peak of up to 18 μg l^{-1} in March (Fig 5d), corresponding with population maxima of *Anabaena solitaria* and *Asterionella formosa* respectively. Comparable peaks of standing crop may be derived from Secchi disc readings of water transparency, particularly when these are plotted as an inverse trace (Fig 5e). The continuation of these readings over the second half of the study period (replacing the chlorophyll *a* determinations to save time) allows recognition of further peaks of biomass in July-September 1977, February-March 1978 (a smaller peak) and the beginning of a further summer peak in July 1978. The correspondence of these biomass-related curves to the

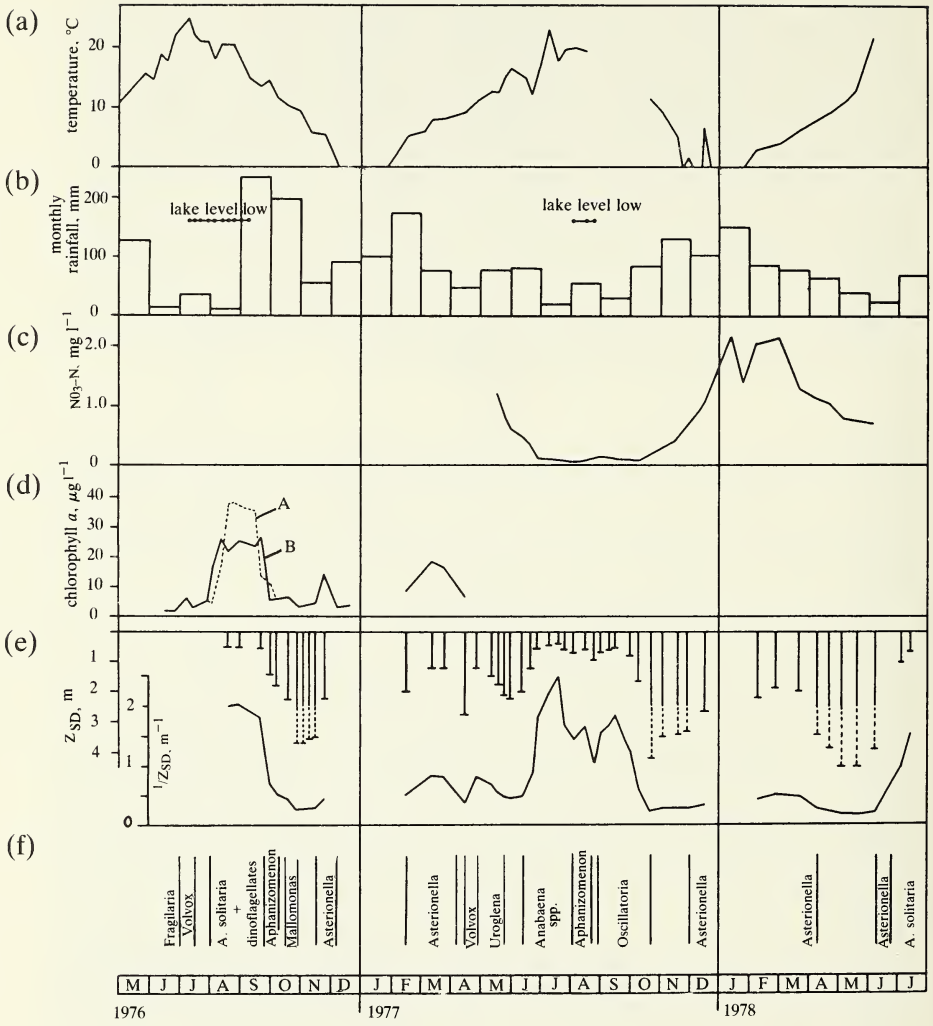

FIGURE 5

Variation of seasonal factors and algal growth in Sawley Dene, 1976-78. (a) surface temperature at Station B: (b) monthly rainfall measured at Lumley Moor reservoir (see text); (c) nitrate-nitrogen in surface water; (d) chlorophyll *a* concentration in 2 m tube samples (Station B) or 4.5 m tube samples (Station A, summer values only shown); (d) Secchi disc extinction depth (Z_{SD}), with same data plotted as reciprocal trace (dashed lines indicate readings taken from Station A at times of very low biomass); (e) changes in dominant species in the phytoplankton.

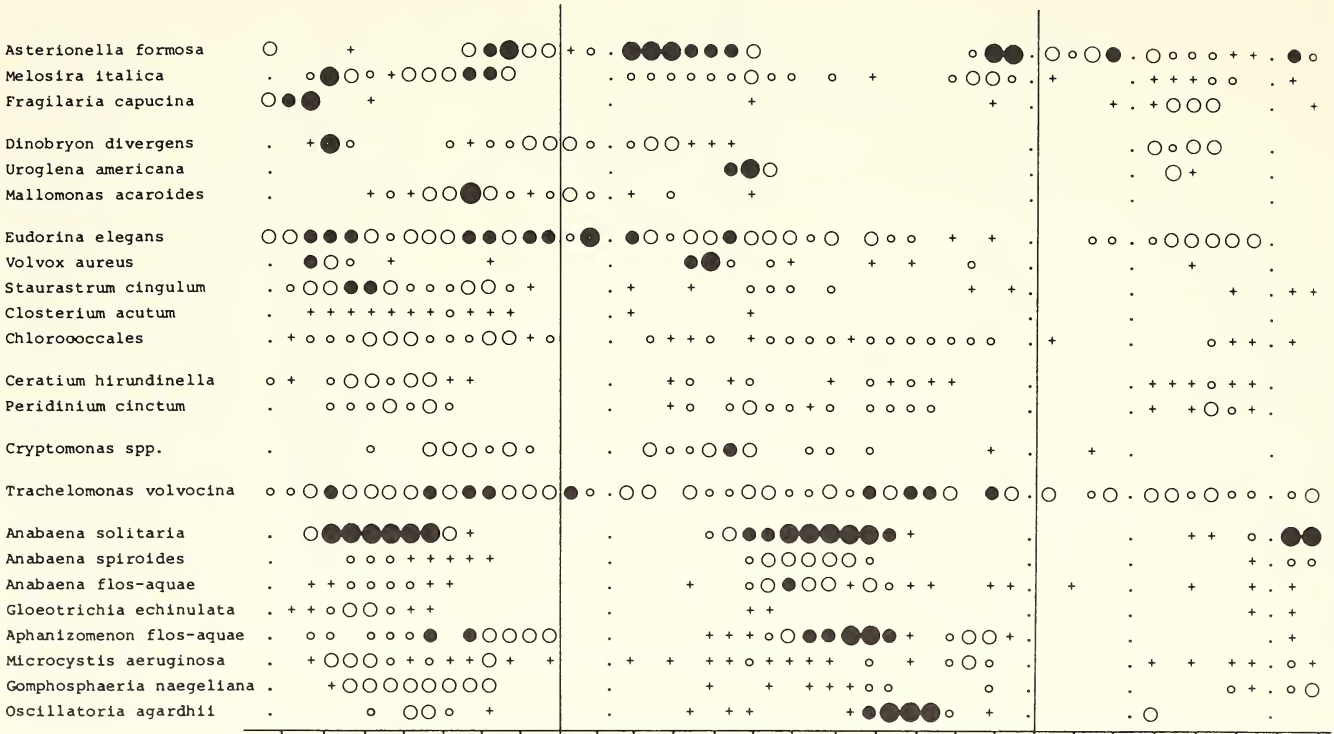

FIGURE 6

Abundance of phytoplankton species estimated from net collections, 1976-78. Abundance categories (see text): + trace, ○ category 1 ○ category 2. ● category 3 ● category 4. Small dot indicates no data obtained.

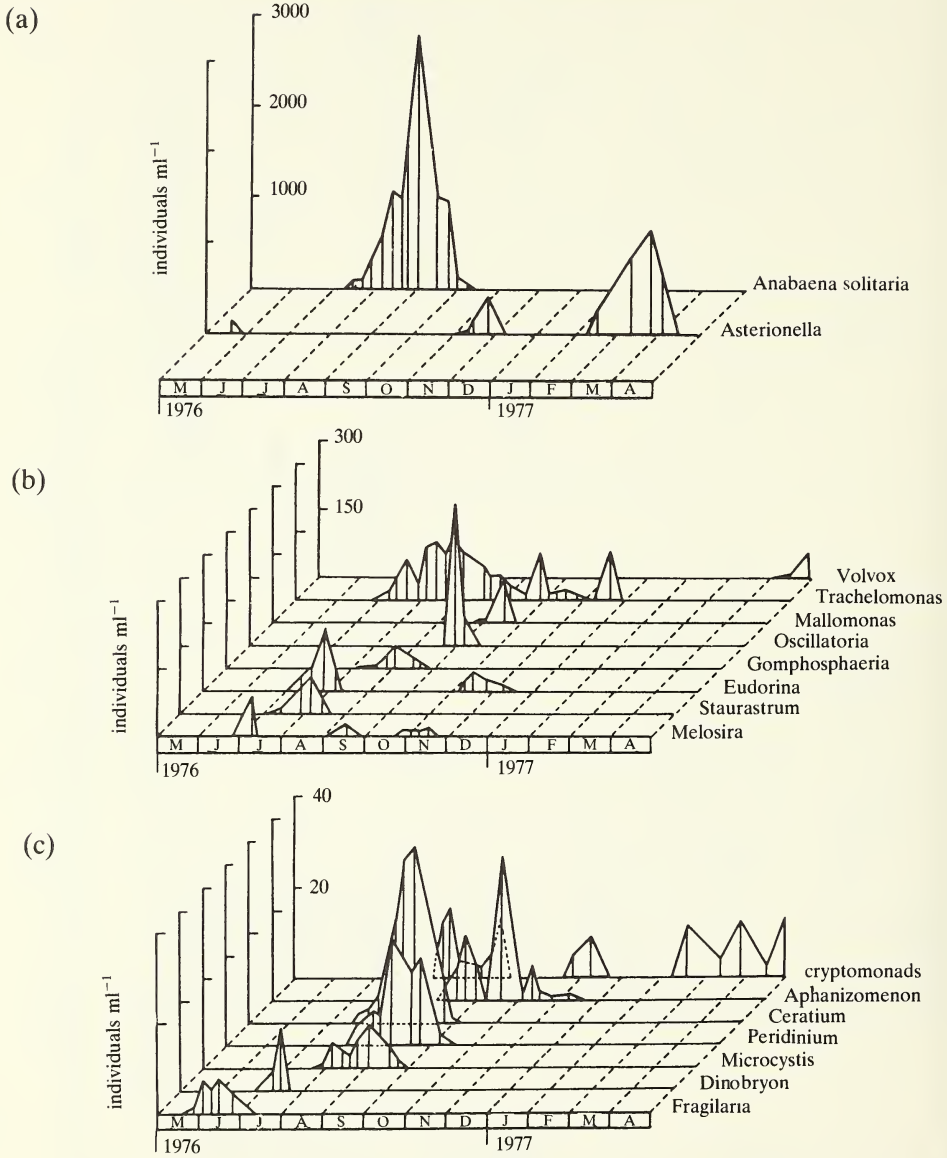

FIGURE 7

Seasonal changes in abundance of phytoplankton in 2 m tube samples, Station B, 1976-77. (a) species exceeding 500 individuals ml^{-1}; (b) species not exceeding 500 individuals ml^{-1}; (c) species not exceeding 50 individuals ml^{-1}. 'Individuals' comprise colonies (*Asterionella, Volvox, Gomphosphaeria, Eudorina, Microcystis, Dinobryon*), filaments (*Anabaena, Melosira, Aphanizomenon, Fragilaria*), 100 μm-filament lengths (*Oscillatoria*), or cells (*Trachelomonas, Mallomonas, Staurastrum*, cryptomonads, *Ceratium, Peridinium*).

succession of principal phytoplankton species is shown in Fig 5f; more complete details of the observed succession are given separately (Figs 6, 7). Fig 6 shows the changes in abundance of twenty-three principal phytoplankton species as determined semi-quantitatively in net collections, while Fig 7 shows growth curves of species exceeding five individuals ml^{-1} over the 1976/7 field season. For clarity, values from Station B only are plotted; values from Station A differ from the Station B values in minor details and are given in Rees (1979).

The succession of species observed was as follows. *Asterionella formosa* produced a spring maximum in 1976 prior to the onset of regular sampling in 1977 (1200 colonies ml^{-1} in March) and a smaller peak in November 1977-February 1978 followed by a brief reappearance in June 1978. In 1976 the decline of spring *Asterionella* populations was followed by growth of *Fragilaria capucina* and *Dinobryon divergens* while in 1977 a population of *Uroglena americana* developed. The next period of algal growth in June-July 1976 was characterized by development of various green algal populations (*Eudorina elegans, Staurastrum cingulum* and small numbers of chlorococcalean species) but populations of these algae were low in 1977 and 1978 (up to July). The period July-October was occupied each summer by a major development of Cyanophyceae. The 1976 peak was dominated completely by *Anabaena solitaria* which reached a maximum of 2800 filaments ml^{-1} in early September, while *Gloeotrichia echinulata, Gomphosphaeria naegeliana* and *Aphanizomenon flos-aquae* developed subsidiary populations; in the 1977 summer a more marked succession of cyanophycean species was observed, with peaks of *Anabaena solitaria* (2700 filaments ml^{-1} in July), *Aphanizomenon flos-aquae* (3700 filaments ml^{-1} in August) and *Oscillatoria agardhii* (18,000 x 100 μm filament lengths ml^{-1} in September) all contributing significantly to phytoplankton production, together with increased quantities of other species of *Anabaena* (*A. flos-aquae, A. spiroides*; see Cmiech, 1981, and Cmiech, Reynolds & Leedale, 1984). The dinoflagellate species *Ceratium hirundinella* and *Peridinium cinctum* were also present in small numbers (less than 50 cells ml^{-1}) during the corresponding period in 1976.

Following the decline of the summer populations of Cyanophyceae, phytoplankton stocks were typically at low levels although a brief bloom of *Mallomonas acaroides* (96 cells ml^{-1}) occurred in October 1976. By late October-early November, development of winter populations of *Asterionella* was seen once more although periods of ice cover and severe mid-winter conditions combined to inhibit growth of populations until spring.

Certain species were present in small numbers throughout much of the year; these included the diatom *Melosira italica* subsp. *subarctica,* the euglenoid *Trachelomonas volvocina* and the green alga *Eudorina elegans*, although growth of the latter became more erratic after mid-1977. Occasional bursts of growth by small *Cryptomonas* and *Rhodomonas* species also occurred throughout the year.

Discussion

It appears possible to identify a general repeating pattern of cyclical change in the Sawley Dene phytoplankton which is quite similar to that described for the epilimnion of many stratified temperate eutrophic lakes, i.e. the 'mixed eutrophic diatom-myxophycean' plankton type of Hutchinson (1967) and the 'principal autogenic sequence' described by Reynolds (1980) for stratified eutrophic systems. In the latter, vernal diatom populations give way to Volvocaceae- and Nostocales-dominated assemblages following the establishment of thermal stratification and these may ultimately be succeeded by *Microcystis* or *Ceratium* populations for the remainder of the stratified period.

A somewhat similar sequence has been described from a few other shallow non-stratifying lakes (Slapton Ley, Devon — Benson-Evans *et al.*, 1967; Cottage Pool, Shropshire — Reynolds, 1973, 1979) but the Sawley Dene pattern is quite different from the irregular growth of the small algae, e.g. chlorococcalean species and cryptomonads, more often dominant in small water bodies (for examples see Reynolds, 1973; Hickman, 1974; Irish, 1977). It might be suggested that the implied ecological stability is more apparent than real and may merely be due to the long retention time and consequent minimal loss of populations by outwash over the two seasons under discussion. However, weather data over a longer period indicate that this is the normal pattern and other parallels with epilimnetic populations seen in larger stratified systems perhaps

require additional explanation. The nitrate data (Fig 5c) suggest that summer in Sawley Dene is a period of nutrient depletion, presumably resulting from utilization of nutrients by the phytoplankton, though any future, more detailed, investigation would need to verify this by measuring levels of ammonia, elemental nitrogen and phosphorus; neither time nor facilities were available for this during the present study. Even so, the idea of nutrient depletion over this period is supported by the successful algal species being ones that tolerate conditions of summer nutrient stress (Reynolds, 1980). Very little replenishment of nutrient levels can occur in Sawley Dene during the summer because of greatly diminished inflow from the catchment area. Excess groundwater after loss by evapotranspiration may be unavailable for the entire period May-early September (according to the data of Smith, 1965) since, although precipitation may exceed evapotranspiration in this area by August, the soil moisture content remains at below field capacity for another 1–1.5 months. Significant nutrient recharge through inflows to the lake would therefore occur at a similar point in the seasonal cycle to the overturn in a stratified system (which makes nutrients available from the former hypolimnetic waters) and would account for the observed similarity in the phytoplankton characteristics between lakes of these two types. Differences in detail for the Sawley Dene succession include the persistence of certain species associated with benthic organic-rich waters (e.g. *Trachelomonas)* throughout the year and the rather small numbers of large dinoflagellates (*Ceratium, Peridinium*) seen in summer. In addition, the absence of a deep undisturbed water layer may allow diatoms such as *Asterionella* and *Melosira* to develop occasional spring or summer populations owing to resuspension from the bottom sediments.

The absence of a detectable soluble reactive phosphorus (SRP) fraction is unexpected since cytological studies on planktonic Cyanophyceae show an abundance of polyphosphate reserves during summer (Cmiech, 1981) which would have been metabolized in conditions of phosphorus limitation. In view of the bloom levels of phytoplankton standing crop which Sawley Dene supports, winter concentrations in the range 25–50 $\mu g\ l^{-1}$ SRP might be expected (Gorham *et al.*, 1974; Carlson, 1977); however, a sample from Sawley Dene collected in February 1980 and analysed at the Freshwater Biological Association Windermere Laboratory yielded the value 3.7 $\mu g\ l^{-1}$ SRP (J. Heron, *pers. comm.*). It would therefore appear that very low levels of soluble reactive phosphorus are a genuine feature of the lake water though non-limiting quantities of phosphorus possibly occur in combined forms or within algal cells.

Other lakes in the region vary in relation to broad geographical factors. In the Sawley area and eastwards over the Vale of York calcareous glacial drift and outcrops of magnesian limestone combine to produce alkaline, often nutrient-rich waters which might be expected to support algal populations of 'eutrophic' type. A single collection from Gormire, near Thirsk, by Scott (1948) included species of *Ceratium, Anabaena, Volvox* and other 'eutrophic' forms in May, while Eavestone Lake (SE/227678), close to Sawley, is of very similar size and shape to Sawley Dene and supports populations of planktonic Cyanophyceae in summer (Rees, 1979). The main eastern flank of the Pennines, however, is formed of millstone grit and supports a more acid and ion-poor water such as is found in Lumley Moor Reservoir and the lakes at Ripley Castle (SE/280609), close to Sawley. Where the underlying carboniferous limestone is exposed in the centre of the Pennine anticline, calcareous waters are again found, as at Malham Tarn, North Yorkshire. Here, Lund (1961) found *Asterionella* in winter/spring (normally less than 500 cells ml^{-1}) and *Anabaena flos-aquae* in summer (occasionally exceeding 1000 filaments ml^{-1}).

Sawley Dene appears to represent a special case where local geological factors that favour the occurrence of 'eutrophic' species combine with unusual hydrological characteristics, resulting in a succession which effectively mimics that observed in the epilimnion of larger stratifying eutrophic lake systems. The interest of Sawley Dene for phycological studies lies in the wide variety of algal populations to be found and their annual recurrence with a certain degree of consistency.

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APPENDIX

List of species recorded in Sawley Dene plankton net collections

Diatoms

Asterionella formosa Hass.
Fragilaria capucina Desm.
Melosira italica Kutz. subsp. *subarctica* Mull.
M. sp (undetermined)
Stephanodiscus sp. (undetermined)

Chrysophytes*

Dinobryon divergens Imhof
Mallomonas acaroides Perty var. *striatula* Asmund
M. akrokomos Pasch. ex Ruttn.
M. alpina Pasch. et Ruttn.
Paraphysomonas vestita (Stokes) de Saedeleer
Synura petersenii Korsh.
Uroglena americana Calkins

Green algae
Ankistrodesmus falcatus (Corda) Ralfs
Asterococcus superbus (Cienk.) Scherff.
Chlamydomonas sp. (undetermined)
Closterium acutum Breb. var. *variabile* Krieger
C. cf. *littorale* Gay
Coelastrum sp. (undetermined)
Dictyosphaerium pulchellum Wood
Elaktothrix gelatinosa Wille
Eudorina elegans Ehrenb.
Pandorina morum Bory
Pediastrum duplex Meyen
Scenedesmus arcuatus Lemm.
Staurastrum cingulum (W. & G. S. West) G. M. Smith
Volvox aureus Ehrenb.

Dinoflagellates
Ceratium hirundinella O. F. Mull.
Gymnodinium sp. (undetermined)
Peridinium cinctum Ehrenb.

Cryptomonads
Cryptomonas ovata Ehrenb. (sens. lat.)
Rhodomonas minuta Skuja

Euglenoids
Euglena cf. *velata* Klebs
E. sp. (undetermined)
Trachelomonas volvocina Ehrenb.
T. sp. (undetermined)

Cyanophytes
Annabaena flos-aquae Breb. ex Born. et Flah.
A. solitaria Klebs
A. spiroides Klebs
Aphanizomenon flos-aquae Raffs ex Born. et Flah.
Gloeotrichia echinulata J. E. Smith
Gomphosphaeria naegeliana (Unger) Lemm.
Microcystis aeruginosa Kutz. emend. Elenk.
Oscillatoria agardhii Gomont
O. sp. (undetermined)

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* additional species identified only after electron microscope studies of isolated scales are given in Rees (1979).

BOOK REVIEWS

A Dictionary of Ecology, Evolution and Systematics by **R. J. Lincoln, G. A. Boxshall** and **P. F. Clark.** Pp. vi + 298, including appendices of maps and tables. Cambridge University Press. 1983. £9.95, paperback.

A welcome and less expensive paperback version of a most useful reference work for naturalists and biologists, previously reviewed in *The Naturalist* (108:161).

Weather in Your Life by **Louis J. Battan**. Pp. vii + 230, including numerous b/w photographs, maps and diagrams. W. H. Freeman & Co. 1983. £17.95 hardback, £8.95 paperback.

The first ninety pages of this book provide a general account of the structure of the atmosphere and general meteorological processes. The effects of weather on transport, agriculture, art, health and comfort, and home and building design are all covered in a relaxed, easy-to-follow, but non-rigorous fashion, in the second part of the book. Though there are many excellent photographs and clear diagrams the treatment is somewhat shallow, and the European reader will be aware of the heavy emphasis on American examples and case studies. The continual use of units such as the inch, foot, degree Fahrenheit, with pressures in lbs per square inch, will mar the book for many students but may appeal to the older generation. The book has a limited quantity of climatic data appended, though 70 per cent of it refers to North America. American sources are again dominant in the references. Overall the book provides a rather expensive broad general introduction to the way the atmosphere operates and the way it may affect man's activities.

DEC

Cambridge Illustrated Thesaurus of Biology by **Anne C. Gutteridge.** Pp. 245, with coloured illustrations. BLA Publishing Limited, 1983. £4.95.

This book gives straightforward dictionary definitions, but is divided into a number of broad subject groups not of equal significance, such as Cells, Classification, Virus, Worms, Plants. An index at the back provides access to some words if their subject classification is unknown, but not all words defined in the thesaurus are included in the index. Words in each section are arranged to indicate relationships, and are not in alphabetical order; this can be confusing and increases the time taken to locate the desired word on the page, eg under the section on plant/type, the word plant as the top entry is followed by vegetation, vegetable, annual, biennial, perennial, etc. Twenty per cent of the words are accompanied by brightly coloured illustrations. Some of these are decorative rather than useful (eg the drawing of a robin to represent the class Aves), while others, such as those illustrating botanical structures, are very explanatory. Biological terms used in the definition of a word are indicated by arrows ($\nearrow$) ($\swarrow$) if they are defined on the same page, or in most cases, cross-referenced by a page number. Where cross-referencing is omitted recourse can be made to the index. Some of the definitions are not entirely explicit or complete, presumably due to space limitations, eg Biological Control is defined only as the 'use of a predator to decrease the population of a pest', and in a book of this size many words are of necessity omitted. The type of user aimed at is not specified, but students up to 'A' level and the general reader interested in Biology are suggested by the presentation. Despite its limitations, once the user has become familiar with the layout of this book, it will provide a quick and useful reference to a wide range of biological subjects.

JMD

Callanish by **William Horwood.** Pp. 192. Allen Lane. 1984. £6.95.

'Written with a Wordstar word processing package on a Rank Xerox 820' boast the publishers; but there is an axiom well known to computer users that the quality of what you get out is only equal to the quality of what you put in. We are told in this book that the birds of prey in the zoological garden in Regent's Park (who later disperse when someone leaves the doors of their cages open) all have personal names known only to themselves (and to the author) and that they constantly carry on long conversations with one another. In the course of these they take a high moral tone, solemnly telling one another what each of them ought to do and repeatedly taking vows about their future conduct; they discuss the places they came from (which apparently they know by name), and also the history of the past 10,000 years or so. All this might be acceptable in a fairy story or an allegory, but used as it is here to support the author's fanatical and irrational hatred of living collections of animals in any form, it is dishonest, distasteful and unconvincing. Using the computer saved the author 70 per cent of his writing time, it is said; anyone tempted to read the resulting book would be well advised to make the saving of their reading time 100 per cent.

FHB

THE ECOLOGY AND DISTRIBUTION OF *CHYDORUS OVALIS* (CLADOCERA: ANOMOPODA) AND ITS RELEVANCE TO THE RECENT HISTORY OF THE SOUTHERN PENNINES

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Over a period of more than thirty years information has been collected on the distribution and ecology of freshwater crustaceans within the boundaries of the old county of Yorkshire. While it is hoped eventually to present the results of this survey as a coherent whole, certain matters are best dealt with separately, one such being treated here.

A striking result of the survey has been the demonstration that, within Yorkshire, many crustaceans belonging to several taxonomic groups are markedly restricted to lowland, generally alkaline habitats, while others are similarly restricted to upland, acidic situations or to such regions and to acidic lowland heaths. The chydorid cladoceran *Chydorus ovalis* Kurz belongs to the latter category. Most records are for upland sites, often at altitudes of over 1000 ft (305 m), and a marked preference for acidic situations is shown. This paper describes the ecological preferences (or requirements) of *C. ovalis*, the pattern of distribution to which they give rise, and the light that past and present distributions throw on the recent history of the Southern Pennines.

Ecology

Including two old unpublished records gleaned from the notes of the late D. J. Scourfield, *C. ovalis* has been recorded from 79 discrete sites in Yorkshire, though some of these occur in clusters in small well-worked areas, as for example on Great Shunner Fell in the Northern Pennines or at Austwick and Lawkland Mosses in the Craven area. As little precise information is on record concerning the ecology of *C. ovalis* in Britain — the excellent key of Scourfield & Harding (1966) for example merely says 'widely distributed' and gives no indication of the restricted range of habitats frequented — a summary of the findings is appropriate, and indeed necessary, as an explanation of the pattern of geographical distribution.

In Yorkshire, *C. ovalis*, adult females of which seldom exceed 0.6 mm in length, is essentially a species of upland, acidic moorlands. Most records are for sites at altitudes of over 1000 ft (305 m) and it has been found several times above 2000 ft (610 m), as on Baugh Fell and Great Shunner Fell, the greatest altitude being about 2180 ft (665 m) in the latter region. Provided conditions are suitable, however, it also occurs at low altitudes and frequents similar habitats provided by certain lowland heaths.

An important feature of its preferred habitats is that they are generally small, often very small, volumes of water. In many cases material was collected by pushing a tube or small jar into tiny pools or clumps of *Sphagnum* rather than by means of a net. A similar association with small volumes of water was noted on the island of Rhum (Inner Hebrides) where *C. ovalis* was found at twenty sites (Fryer & Forshaw, 1979). Chemical data are available for some sites and these are given in Table 1. All measured pH values ($n = 29$) were acidic, and this undoubtedly applied also to the vast majority, if not all, of the sites for which no measurements were made. Low concentrations of calcium and of salts generally are the rule. Minute pools in hollows are much favoured and *Sphagnum* is frequently present: its presence was noted at sixty of the sites and in several cases *C. ovalis* was found in dense masses of soggy *Sphagnum* among whose 'roots' it apparently found sufficient water for its needs. Such habitats are the sort of places in which 'terrestrial' chydorids living in humid forests (Frey, 1980) must have become emancipated from complete submergence. In such places only crawling is likely to be possible but *C. ovalis* can swim well when necessary (Fryer, 1968). A similar frequent association with *Sphagnum* was noted on Rhum — sixteen of the twenty recorded sites (Fryer & Forshaw, 1979).

Somewhat larger expanses of water are sometimes colonized, but none of the records refer to large tarns. In cases which involve small tarns, occupation seems to be restricted to sheltered

areas. Thus at Pickersett Tarn on Great Shunner Fell *C. ovalis* was found only at one point where there was much *Sphagnum* at the margin, at Dirty Pool it was found only in a marginal *Sphagnum* patch, and at the much overgrown Cotter End Tarn only among *Carex* and *Sphagnum* at the margin. At Strensall Common it was found among *Potamogeton polygonifolius* in very shallow water over mud at the margin of a large pool but not in the pool itself, and it shunned a pond at Pilmoor although it occurred in nearby *Sphagnum*. It has, however, been found in a peaty-bottomed pond about 5 m in diameter.

The commonest crustacean associates of *C. ovalis* are instructive indicators of its ecological preferences. Most frequent was the congeneric and closely related *C. sphaericus* (O.F. Müller) (forty-seven times), a species so tolerant that its presence tells one little about the habitat. That two such closely related species should so frequently co-exist in what are often very restricted habitats is nevertheless of ecological interest. Most other common associates were copepods. *Moraria brevipes* (Sars) (thirty-eight cases) is a minute *Sphagnum*-frequenting harpacticoid and *Bryocamptus pygmaeus* (Sars) (twenty-eight) is another, often moss-frequenting harpacticoid of wider tolerance. Nine other harpacticoid copepods were recorded as associates but none was as frequent as were the cyclopoids *Acanthocyclops languidus* (Sars) (thirty-three), *A. venustus* (Norman & Scott) (twenty-six), *A. nanus* (Sars) (eighteen) and *A. vernalis* (Fischer) (sixteen). In Yorkshire the first three of these are species with definite preferences for acidic, moorland sites to which they are largely or entirely confined, and although *A. vernalis* occurs more widely, it too shows a distinct preference for such situations (Fryer, in press).

TABLE 1

Chemical conditions at certain sites frequented by *Chydorus ovalis* in Yorkshire. Standard errors are given when sufficient data are available to merit this.

	x ± SE	Range	n
pH	4.71 ± 0.214	3.15 – 6.9	29
Ca^{2+} (mg l^{-1})	12.9 ± 2.94	0.65 – 510	24
Mg^{2+} (mg l^{-1})	1.17 ± 0.184	0.3 – 4.2	25
Na^{+} (mg l^{-1})	7.48 ± 2.89	2.09 – 43.0	14
K^{+} (mg l^{-1})	0.98 ± 0.24	0.12 – 3.2	14
Conductivity ($\mu S\ cm^{-1}$ at 25°C)	106.7	51 – 386	7

Other than *Chydorus sphaericus*, cladoceran associates were of relatively rare occurrence, the commonest being the chydorids *Alonella excisa* (Fischer) (six), *A. nana* (Baird) (five), *Alona rustica* (Scott) (four) and the macrothricid *Acantholeberis curvirostris* (O.F. Müller) (three). Of the chydorids *A. rustica* is basically an acidophilic sphagnophile in Yorkshire, the other two are more tolerant but with some preference for acidic sites, especially in the case of *A. nana*. *Acantholeberis curvirostris* is a typical inhabitant of acidic pools and is often associated with *Sphagnum*. The relatively small number of cases in which it was associated with *C. ovalis* reflects the preference of the latter for small habitats. Although *A. curvirostris* lives in small pools it demands at least a little 'open' water. Several of these crustaceans were recorded, sometimes frequently, as associates of *C. ovalis* on Rhum (Fryer & Forshaw, 1979).

While the seasonal cycle has not been specifically studied it can be recorded that although ephippia (see below) are produced towards the end of the year at some sites, active adults can be found even beneath ice in December. Thus, in December 1978 adults were collected from tiny frozen pools near The Fleak (between Wensleydale and Swaledale), where access to water was gained only by breaking the ice at their mossy margins, and also from a seepage on Gayle Moor that was covered by a crust of ice.

These findings are in general agreement with such information as is recorded for continental populations (see Flössner 1972 for summary). In Europe *C. ovalis* has a boreo-montane

distribution with isolated populations in moorland situations elsewhere. Mäemets (1961) has produced the most comprehensive information, including certain chemical data, for Estonian populations and he characterizes *C. ovalis* as an acidophilic species occurring generally in humic, calcium-poor situations, low in nutrients. He notes that it is one of the earliest species to appear in spring and does so at temperatures below 10°C.

In several of these respects the Yorkshire populations tolerate even more extreme conditions. Here *C. ovalis* has been found at pH 3.15 (minimum of Mäemets 4.0), at a calcium level of 0.65 mg l^{-1} (2.4 mg l^{-1}) and active beneath ice. On Rhum, at one of the two sites for which chemical data were obtained it was living in water containing only 0.4 mg l^{-1} of calcium (Fryer & Forshaw, 1979).

Distribution

Fig 1 shows that most sites are for upland areas in the Northern Pennines and adjacent Howgill Fells. In the North-Eastern moorlands, which attain lower altitudes than do those of the Pennines, *C. ovalis* is less well represented. This may in part reflect the smaller amount of collecting done there than in the Northern Pennines but is probably also related to the smaller amount of suitable habitat in the form of small pools and seepages.

There are six lowland sites if Mewith Head, Newby Moor and Austwick Moss be regarded as lowland (*c* 430–525 ft, *c*130–160 m) and the several discrete sites at the contiguous Austwick and Lawkland Mosses are treated as one. Five of these are acidic heaths or mosses though the site at Newby Moor was only weakly acidic (pH 6.7) and relatively rich in calcium (46.1 mg l^{-1}). The sixth is near Wilfholme in the south-east. I did not collect this material myself but identified specimens collected by G.W. Lightfoot in 1970 from some marshy land adjoining the River Hull. No chemical data are available but, with the exception of *Alonella excisa* and the virtually ubiquitous *Chydorus sphaericus*, the associated chydorids (only chydorids were seen) are species that show only limited tolerance to acidic water. Initially this appeared to represent an atypical site, but a soil map shows that it lies in an island of humic alluvial gley soils, which suggests that the area may be somewhat acidic. If this is so then what would otherwise be the only anomalous location ceases to be so.

A striking feature revealed by the map is the apparent absence of *C. ovalis* from the Southern Pennines. While negative results can never be absolutely conclusive, this is almost certainly not due to inadequate searching. The area has been explored both in the vicinity of Huddersfield (Fryer, 1955) and elsewhere. Thus in 1982 a number of apparently suitable sites in the Langsett-Harden Moor-Featherbed Moss area were specially investigated. As a result *C. sphaericus* was found at nineteen sites, as well as at others both north and south of the area, *C. ovalis* at none. *C. ovalis* is not the only crustacean to display such a pattern of distribution. The macrothricid cladoceran *Acantholeberis curvirostris* and the cyclopoid copepod *Acanthocyclops nanus* exhibit very similar patterns. *A. curvirostris* is common and widespread in suitable habitats in both the Northern Pennines and on the North-Eastern moorlands and has been recorded in two lowland heathy areas, Skipwith Common and Thorne Waste. *A. nanus* is also common and widespread in the Northern Pennines, has been found twice in the North-East and occurs at Austwick Moss. Neither has been seen in the Southern Pennines.

By contrast some small crustaceans favouring acidic situations, such as the bosminid cladoceran *Bosmina coregoni* Baird, the cyclopoid copepods *Acanthocyclops venustus* and *A. languidus*, and the harpacticoid copepod *Moraria brevipes*, occur throughout the entire length of the Pennines, and the copepods have been found also at certain acidic lowland sites, such as Strensall Common where all three occur, but are otherwise absent from the lowlands.

The evidence therefore suggests that *C. ovalis* is not present in the Southern Pennines, or if it is it is very rare. This situation has not always prevailed. Thanks to Dr J. Tallis I have been able to examine peat samples taken on Robinson's Moss just outside the Yorkshire boundary (Fig 1) from sites at which *Sphagnum* pools formerly existed. In a region of unhumified *Sphagnum* peat about 0.5 m beneath the present surface I recovered remains of *C. ovalis*. These included numerous ephippia (Fig 2) — the packets made from part of the carapace valves and the enclosed resting egg or eggs that are produced from time to time as the outcome of sexual reproduction. These were readily recognizable because they contained two resting eggs (Fryer &

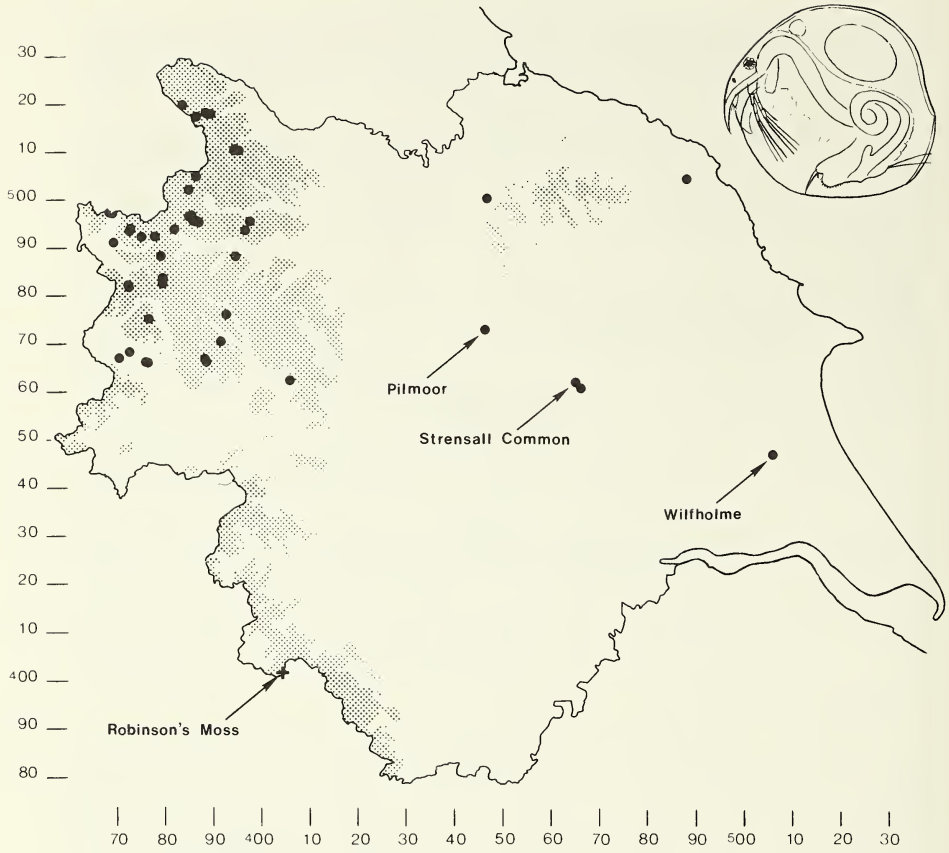

FIGURE 1

The recorded distribution of *Chydorus ovalis* in Yorkshire. Land over 1000 ft (305 m) stippled. The inset shows a parthenogenetic female. A considerable number of discrete sites from which this species has been recorded are too close together to be shown by separate spots on the map. The three 'lowland' sites in the west are Mewith Head, Newby Moor, and Austwick and Lawkland Mosses, whose altitudes are approximately 525, 500 and 430 ft (*c* 160, 152 and 130 m) respectively. The named sites on the lowland plains all lie below 100 ft (*c* 30 m). Robinson's Moss is the site of fossil finds.

Frey, 1981). Other fragments, including carapaces and the distinctive post-abdomen, were also recovered. That fossil ephippia should be found so soon after the discovery that, unlike any other European member of the genus, *C. ovalis* deposits two resting eggs, and not one, in the ephippium, is an interesting example of how one discovery helps another, for this enabled the fossil ephippia to be immediately recognized. In spite of their delicate nature, the egg membranes preserve extremely well.

The age of the deposits has not been precisely determined, but Dr Tallis anticipates that they will prove to be of 'Dark Age' date (c.400–800 AD), an age that can be attributed with certainty to peat in a similar situation on Featherbed Moss.

FIGURE 2
Fossil ephippia of *Chydorus ovalis* from peat deposits on Robinson's Moss. Note the remarkable preservation of the egg membranes.

In the deposits, which consisted largely of well-preserved *Sphagnum* leaves, the remains of *C. ovalis* were accompanied by those of other chydorids — *Chydorus sphaericus* whose single-egged ephippia were plentiful, *Alonella excisa, A. nana,* and *Alona rustica.* This assemblage is essentially the same as that discovered by Gurney, in peat, at what depth/age is unstated, collected at Askrigg Common (Northern Pennines) by Burrell & Cheetham (see Burrell, 1924). This included *Alonella excisa, A. nana* 'and possibly *A(lona) rustica*' as well as 'numbers of *Chydorus* which might be *C. ovalis* but it was impossible to be sure'.

Of the species formerly living at Robinson's Moss the acidophilic *Alona rustica* is recorded in Yorkshire only from the Pennines (more often in the North than in the South), the Howgill Fells and the North-Eastern moorlands. *Alonella excisa* is a remarkably versatile species occurring both on moorland and elsewhere in Yorkshire, with a scattering of records for the Northern Pennines and the North-Eastern moorlands, but with only a single record for the Southern Pennines. *A. nana* is similarly versatile but with a much greater association with acidic moorland in Yorkshire. It is recorded from the North-Eastern moorlands, is common and widespread in the Northern Pennines, but has been found at only one truly moorland site in the Southern Pennines.

Thus there were once *Sphagnum* pools on Robinson's Moss that were inhabited by a species (*C. ovalis*) that has not been found in the Southern Pennines in recent years and by two species (*A. excisa* and *A. nana*) that are not common there today. The present-day distribution patterns of certain crustaceans suggest ecological differences between the Northern and Southern Pennines; the fossil remains indicate that such differences may not always have prevailed. This is in keeping with well documented changes in the vegetation, of which those that have occurred during the past two centuries are a subject of current investigation and concern. These include the increasing rarity, or near disappearance, of various flowering plants such as *Andromeda polyfolia, Drosera intermedia* and several others, and a marked diminution in the incidence of *Sphagnum*, several species of which appear to have become extinct and others to have been greatly reduced in abundance (see Anderson & Shimwell, 1981, for a readable summary of the work of those involved). These changes are associated with an increase in the frequency of Heather burning, increased grazing pressure from sheep, the construction of reservoirs and some associated modification of drainage, and with the increase in atmospheric pollution by smoke and by oxides of sulphur and nitrogen that has taken place since the industrial revolution, and the related and much discussed phenomenon of acid rain (e.g. see Ferguson & Lee, 1983; Press, Ferguson & Lee, 1983). To attribute the rarity or absence of certain species of crustaceans in the Southern Pennines to the effects of the last-mentioned phenomenon perhaps demands more than a simple comparison of chemical differences between the waters of the Northern and

Southern Pennines. If pollution is responsible, sudden pulses of high acidity, or perhaps occasional extra-heavy deposition of heavy metals, may have been involved, and synergistic effects involving factors as yet unappreciated may also have played a part. No definite conclusions in this respect are therefore drawn here. It would also be helpful, should it be possible to find a site with a long history as a region of *Sphagnum* pools, to trace the chronological sequence of chydorid cladocerans there and to ascertain the time at which species such as *C. ovalis* became extinct. Nevertheless the evidence provided by both past and present distribution patterns of small crustaceans, coupled with a knowledge of their ecological requirements and tolerances, provides a useful item of evidence in the unravelling of a complex and economically important situation.

Summary

In Yorkshire the chydorid cladoceran *Chydorus ovalis* frequents acidic water bodies, usually of small, often very small, size, and is frequently associated with *Sphagnum*. Its preferences give rise to a distinctive pattern of distribution. It is largely confined to upland, moorland regions and to a few isolated lowland heaths. Within the available range, altitude is of itself unimportant.

While common in the Northern Pennines, and recorded from the North-Eastern moorlands, it has not been recorded as a member of the present-day fauna of the Southern Pennines. However, fossil finds from the site of former *Sphagnum* pools at Robinson's Moss, just outside the Yorkshire boundary, and probably dating from *c*400–800 AD, show that *C. ovalis* formerly occurred in abundance in at least one place in the Southern Pennines. Its apparent disappearance from the region (if it occurs at all it is certainly much rarer than in the Northern Pennines) parallels the disappearance, or the reduction in abundance, of several flowering plants, and of *Sphagnum*, in the same area during the past two centuries or less, and may be related to the deposition there of air-borne pollutants.

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THE SPIDERS AND HARVESTMEN OF SOME PEAT AND UPLAND GRASSLAND SITES IN YORKSHIRE

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Introduction

As part of a study on the invertebrate fauna of upland and peat soils in northern England, 15 sites were selected for study in northern Yorkshire, 13 on peat and 2 on upland grasslands. This paper reports on the spiders and harvestmen collected in this study. A new species of harvestman has been described from material collected during this survey, *Mitopus ericaeus* Jennings, and new locality records for this species are given.

Methods

All of the material was obtained by means of pitfall traps sunk into the ground. At each site, ten traps were placed 2m apart in a straight line. Sampling extended from August 1976 to the end of November 1977 and a total of over 6,500 spiders and 500 harvestmen were collected. The area covered by the traps at each site was relatively small, but the trapping area was selected as being representative of a much larger area. Seven of the peat soil sites were in the North York Moors, six peat and one grassland site were in the Yorkshire Dales region of the Pennines. One peat and one grassland site near Ingleborough were also studied. The details of the 15 sites are given in Table 1.

The spiders have been identified using the Ray Society's 3 volume key to British Spiders (Locket & Millidge, 1951, 1953; Locket, Millidge & Merrett, 1974). All of the names used correspond to the check list in Volume III, and the number given before each species corresponds to the number given on the distribution maps in Volume III. Dr P. Merrett kindly confirmed the identity of one specimen of each spider species. The harvestmen were identified by the use of Sankey and Savory's (1974) key. The description of *Mitopus ericaeus* is given in Jennings (1982).

Results and Conclusions

The abundance and distribution of the 134 species of spiders recorded in this study are given in Table 2. Nine species were not recorded in north Yorkshire in the distribution maps published in 1974 (Locket, Millidge and Merrett, 1974) but all except *Lepthyphantes insignis* are included in *An Atlas of Yorkshire Spiders* (Smith, 1982). Of particular interest are the first two records of *Oreonetides vaginatus* for Yorkshire, the only two recent records of *Jacksonella falconeri*, a new locality for *Rhaebothorax morulus* and two localities for *Porrhomma campbelli.*

The peat sites on the North York Moors (sites 3–9) and in the Pennines (sites 10–15), allow a comparison of the distribution of spiders on these two regions of moorland. The following species were recorded at several peat sites in the Pennines but were not found on the North York Moors: *Coelotes atropos, Walckenaera clavicornis, W. cuspidata, Hypomma bituberculatum, Diplocentria bidentata, Erigone dentipalpis, E. promiscua, Lepthyphantes angulatus* and, surprisingly, *Centromerita bicolor.* Species found on the North York Moors but absent from the Pennine sites are: *Ceratinella brevis, Walckenaera unicornis, Bathyphantes parvulus* and *Microlinyphia pusilla.* Examination of Table 2 also reveals other species which appear to be much more frequent in one or the other of these two regions.

These differences in distribution are unlikely to arise from the types of moorlands in these two regions. In both regions, sites on dry heath, blanket peat and on areas of 'mixed' moor were sampled. It should be noted, however, that areas of deep, blanket peat are infrequent on the North York Moors and the site studied there, Botton Cross, lacked several species normally associated with such areas on the Pennines. It is possible that certain of these species, associated with blanket peats, no longer occur on the North York Moors.

TABLE 1
The location and characteristics of the study sites.

	Grid ref.	Altitude (m)	Rainfall (mm)	Peat depth (mm)	pH	Dominant vegetation
Mineral (grassland) sites						
1 Apedale alluvial	SE 022943	388	1180	0	7.1	G
2 Scar Close (limestone)	SD 754780	336	1700	0	4.3	G
North Yorks Moor peat sites						
3 Job Cross	NZ 692110	259	910	1000	3.7	C
4 Yarlsey	NZ 750007	305	1020	130	3.7	C
5 Tranmire	NZ 762117	213	910	100	3.8	C
6 Murk Mire	NZ 797025	240	780	1000	4.2	C/Je
7 Fen Bog	SE 852974	198	880	1000	3.8	C/E
8 Kildale	NZ 620111	274	880	80	3.8	C
9 Botton Cross	NZ 701017	427	900	1000	3.6	E
Pennine peat sites						
10 Rowantree Scar	SE 032932	411	1050	100	3.7	C/Js
11 Apedale	SE 022943	396	1180	60	3.7	C
12 Scar Close	SD 755779	336	1700	340	3.7	C/E
13 Newby Head Moss	SD 795836	427	1950	460	3.6	Js
14 Golden Groves	SE 044945	457	1100	250	3.6	C
15 Beldon Bottom	SD 967940	488	1500	1000	3.6	C/E

G = Grasses; C = *Calluna vulgaris*; Je = *Juncus effusus*; Js = *J. squarrosus*; E = *Eriophorum vaginatum*.

TABLE 2

The spider species recorded at 15 localities in North Yorkshire. The first two sites are on grasslands with mineral soils in the Pennine uplands. The remaining sites are all peat soils on the North York Moors or in the Pennine uplands. Details of the sites are given in Table 1.
o indicates that 1-10 specimens were taken in ten traps in a year; A indicates abundant species where more than 10 specimens were taken each year.

	GRASS		PEAT North York Moors							PEAT Pennines					
	Apedale alluvial	Scar Close (limestone)	Job Cross	Yarsley	Tranmire	Murk Mire	Fen Bog	Kildale	Botton Cross	Rowantree Scar	Apedale	Scar Close	Newby Head Moss	Golden Groves	Beldon Bottom
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AMAUROBIIDAE															
Amaurobius fenestralis		o													
DYSDERIDAE															
Segestria senoculata		o													
GNAPHOSIDAE															
Drassodes cupreus			o				o								
Haplodrassus signifer	o	o	o	o	o	o	o	o	o		o	o		o	o
Gnaphosa leporina			o	A	o	o			o					o	
Micaria pulicaria		o													
CLUBIONIDAE															
Clubionia reclusa							o								
C. trivialis		o	o	o	o		o	o	o	o	o			o	o
C. diversa		o					o								
Agroeca proxima		o	o	o	o	o	o	o		o	o	o			o
THOMISIDAE															
Xysticus cristatus	o	A	o		o		o		o	o	o	o	A	o	
SALTICIDAE															
Noen reticulatus			o												
Euophrys aequipes						o	o								
LYCOSIDAE															
Pardosa monticola	o														
P. palustris	A		o	o	A	o				A	A		o		o
P. pullata	A	A	o	o	o	o	A		o	A	A	A	o	A	A

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
P. amentata	o			o	o	o							o		
P. nigriceps		A	A	A	A	A	A	A		A	A	A		A	A
Alopecosa pulverulenta	A	o	A	A	o	A	A	A	A	A	A	A	A	A	A
A. accentuata					o				o						
Trochosa terricola	A	A	A	o	A	o	A		o	o		o	A	o	
T.spinipalpis							o		o						
Pirata piraticus	o		o			o	A			o		A	A	A	A
P. hygrophilus							o								
P. uglinosus							A								
AGELENIDAE															
Coelotes atropos	o	A								o	o	o		o	o
Cryphoeca silvicola		o													
Antistea elegans	o		o		A	A	o	o				A	A		o
Hahnia helveola							o								
H. pusilla							o								
NIMETIDAE															
Ero cambridgei					o					o				o	
E. furcata								o		o					
THERIDIDAE															
Robertus lividus	o	o	o	A	A	o	o	A	o	o	o	o	o	A	o
R. arundineti		o										o	o		
Theonoe minutissima			o	o		o	o	o							
TETRAGNATHIDAE															
Pachygnatha clercki						o							A		
P. degeeri	o	A	o	o	o	o	A	o	A	A			A		
LINYPHIIDAE															
Ceratinella brevipes	o		A	A	A	A	o	A	A	A	A	o	o	A	o
C. brevis			A	o	o	A	o	o							
Walckenaera acuminata	o	A		A	A	o		A	o	A	o	o	o	A	o
W. antica	o	o	o	o		o	o	A	A	o	A		A	A	
W. nodosa													o		
W. melanocephala													o		
W. nudipalpis	o	o	o	o		o	o		A	o	o	o	A	A	o
W. monoceros	o					o									
W. unicornis	o			o		o	o	A	o						
W. kochi	o		o												
W. clavicornis	o									o		A			o
W. cuspidata	o	o												o	A
W. vigilax		o				o	o			o		o			
Dicymbium brevisetosum	A	A				o									o
D. tibiale						o					o				
Dismodicus bifrons						o									

Hypomma bituberculatum													o	o		o
Gonatium rubens	o	A	A	o	o	A	o	o		o	o	A	o	A	A	
Minyrioloides trifrons													o			
Maso sundevalli			o													
Peponocranium ludicrum			o		o			o		o				o		
Pocadicnemis pumila		o	A			o	A					o				
Hypselistes jacksoni			o			o	o		A			o		o	o	
Oedothorax gibbosus	A	o				A	o		o	A		o	A	o		
O. tuberosus	A	o				A	A	o					A	o		
O. fuscus	A	o	o					o		o					o	
O. retusus	A	A	o		o		o	o	o	A	o		o			
Trichopterna mengei			A	A	o	A	A	A	A	A	o	o		A		
Pelecopsis parallela	A															
Silometopus elegans	A	A	o	o	o	A	A			A		A	A	o	o	
Cnephalocotes obscurus						o		o	o			o	A			
Tiso vagans	A	o			o					o	o					
Minyriolus pusillus						o										
Tapinocyba praecox			o	A	o	o		A		o						
T. pallens	o		o	o				o								
Monocephalus fuscipes	o	A						o		o						
Lophomma punctatum	o					o								o		
Jacksonella falconeri				o									o			
Gongylidiellum vivum							o	o		o						
G. latebricola													o			
Micrargus herbigradus	A	o	o	o	o	o	o	A		A	o	A	o	o	o	
Notioscopus sarcinatus			o			o										
Erigonella hiemalis	o	o			o			o			o		o			
Savignya frontata	o							o		o			o			
Diplocephalus cristatus		o														
D. permixtus	o	o								o		o		A		
Araeoncus humilis		o														
A. crassiceps		o		A		o	o		o			A				
Caledonia evansi					o						o			o		
Typochrestus digitatus	o										o			o		
Diplocentria bidentata												o	A	o	A	
Erigone dentipalpis	A	o								A				o	o	
E. atra	A	o			o		o	o		o	o	o	o			
E. promiscua	A	o								A	o	o		o		
Rhaebothorax morulus											o					
Eboria fausta	o													o		
Leptorhoptrum robustum													o			
Drepanotylus uncatus											o	o		o	o	
Phaulothrix hardyi			o								A					

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
P. amentata	o			o	o	o							o		
P. nigriceps		A	A	A	A	A	A	A		A	A	A		A	A
Alopecosa pulverulenta	A	o	A	A	o	A	A	A	A	A	A	A	A	A	A
A. accentuata					o				o						
Trochosa terricola	A	A	A	o	A	o	A		o	o		o	A	o	
T. spinipalpis							o		o						
Pirata piraticus	o		o			o	A			o		A	A	A	A
P. hygrophilus							o								
P. uglunosus							A								
AGELENIDAE															
Coelotes atropos	o	A								o	o	o		o	o
Cryphoeca silvicola		o													
Antistea elegans	o		o		A	A	o	o				A	A		o
Hahnia helveola							o								
H. pusilla							o								
NIMETIDAE															
Ero cambridgei					o					o				o	
E. furcata								o		o					
THERIDIDAE															
Robertus lividus	o	o	o	A	A	o	o	A	o	o	o	o	o	A	o
R. arundineti		o										o	o		
Theonoe minutissima			o	o		o	o	o							
TETRAGNATHIDAE															
Pachygnatha clercki						o							A		
P. degeeri	o	A	o	o	o	o	A	o	A	A			A		
LINYPHIIDAE															
Ceratinella brevipes	o		A	A	A	A	o	A	A	A	A	o	o	A	o
C. brevis			A	o	o	A	o	o							
Walckenaera acuminata	o	A		A	A	o		A	o	A	o	o	o	A	o
W. antica	o	o	o	o		o	o	A	A	o	A		A	A	
W. nodosa													o		
W. melanocephala													o		
W. nudipalpis	o	o	o	o		o	o		A	o	o	o	A	A	o
W. monoceros	o					o									
W. unicornis	o			o		o	o	A	o						
W. kochi	o		o												
W. clavicornis	o									o		A			o
W. cuspidata	o	o												o	A
W. vigilax		o				o	o			o		o			
Dicymbium brevisetosum	A	A				o									o
D. tibiale						o					o				
Dismodicus bifrons						o									

Hypomma bituberculatum												o	o		o
Gonatium rubens	o	A	A	o	o	A	o	o		o	o	A	o	A	A
Minyrioloides trifrons													o		
Maso sundevalli			o												
Peponocranium ludicrum			o		o			o		o				o	
Pocadicnemis pumila		o	A			o	A					o			
Hypselistes jacksoni			o			o	o		A			o		o	o
Oedothorax gibbosus	A	o				A	o		o	A		o	A	o	
O. tuberosus	A	o				A	A	o					A	o	
O. fuscus	A	o	o					o		o					o
O. retusus	A	A	o		o		o	o	o	A	o		o		
Trichopterna mengei			A	A	o	A	A	A	A	A	o	o		A	
Pelecopsis parallela	A														
Silometopus elegans	A	A	o	o	o	A	A			A		A	A	o	o
Cnephalocotes obscurus						o		o	o			o	A		
Tiso vagans	A	o			o					o	o				
Minyriolus pusillus						o									
Tapinocyba praecox			o	A	o	o		A		o					
T. pallens	o		o	o				o							
Monocephalus fuscipes	o	A						o		o					
Lophomma punctatum	o					o								o	
Jacksonella falconeri				o									o		
Gongylidiellum vivum							o	o		o					
G. latebricola													o		
Micrargus herbigradus	A	o	o	o	o	o	o	A		A	o	A	o	o	o
Notioscopus sarcinatus			o			o									
Erigonella hiemalis	o	o			o			o			o		o		
Savignya frontata	o							o		o			o		
Diplocephalus cristatus		o													
D. permixtus	o	o								o		o		A	
Araeoncus humilis		o													
A. crassiceps		o		A		o	o		o			A			
Caledonia evansi					o						o			o	
Typochrestus digitatus	o										o			o	
Diplocentria bidentata												o	A	o	A
Erigone dentipalpis	A	o								A				o	o
E. atra	A	o			o		o	o		o	o	o	o		
E. promiscua	A	o								A	o	o		o	
Rhaebothorax morulus											o				
Eboria fausta	o													o	
Leptorhoptrum robustum													o		
Drepanotylus uncatus											o	o		o	o
Phaulothrix hardyi			o								A				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hilaira excisa														o	
H. nubigena															A
Porrhomma pallidum							o	o							
P. campbelli	o					o									
P. montanum				o										o	
Agyneta subtilis		o													
A. conigera			o	o	o			o			o	o			
A. decora	A				o							o	A	A	o
A. cauta	o	o													o
Meioneta rurestris	o		o	o	o		o		o					o	
M. saxatilis	o		o		o	o	o	o					o		
M. beata			o				o								
Centromerus expertus	o					A	o							o	A
C. prudens	o			o						o	o			A	o
C. arcanus						o		o							
C. dilutus			o				o	o	o			o		o	
Centromerita bicolor	A	A								o	o	o	A	o	
C. concinna	A	A	o	A	A	o		A	A	A	A	A	A	A	A
Sintula cornigera								o						o	
Oreonetides abornmis			o			o		o		o	o			o	o
O. vaginatus														o	o
Macrargus rufus															o
Bathyphantes gracilis	A	o			o	A	o	o		o	o	o	o	A	A
B. parvulus					o	o	o								
B. setiger										o					
Diplostyla concolor		A												o	
Poeciloneta globosa					o				o		o			o	
Tapinopa longidens			o		o							o			o
Stemonyphantes lineatus		o					o	o	o	o	o			o	o
Bolyphantes luteolus	o	o	o	o	o	o		o	o	o	A	o	o	o	A
Lepthyphantes tenuis	o		o	o	o		o	o		o					
L. zimmermanni		o	A	o	o	A	o	A	o	A	A	o		A	A
L. mengei	o	o	A	o	A	A	A	A	A	A	A	A	o	A	o
L. ericaeus	o	A	A	A	A	A	A	A	A	A	A	o	A	A	o
L. insignis	o						o								
L. angulatus	o									o	o	A	o	o	A
Microlinyphia pusilla			o		o		o								
Allomengea scopigera	o				o	o		o		A	A		o	A	A

TABLE 3

The distribution of harvestmen (Opiliones) in north Yorkshire. Symbols as in Table 2.

	GRASS		PEAT North York Moors							PEAT Pennines					
	Apedale alluvial	Scar Close (limestone)	Job Cross	Yarlsey	Tranmire	Murk Mire	Fen Bog	Kildale	Botton Cross	Rowantree Scar	Apedale	Scar Close	Newby Head Moss	Golden Groves	Beldon Bottom
Nemastoma bimaculatum	o	A	A	A	o	A		A	o	o	o			A	A
Mitostoma chrysomelas		o	A	A		o								o	o
Mitopus morio	A	o	A	A	A	A		A	A	A	o	o	A	A	A
M. ericaeus	o		A	o	o	o		o	o	o	o	o		o	o
Phalangium opilio							o								
Platybunus triangularis			A	o	o	o	o			o				o	
Lacinius ephippiatus	o		A		o	o		o		o	o			o	o
Megabunus diadema		o													
Oligolophus tridens	o			o			o				o	o			
O. agrestis	o	o	A	o	A	o	o	o		A	o	o	o	o	o
O. palpinalis			A		A	A	o	A		A					o

Two species of harvestmen were recorded from only one site. Apart from these, all of the other species were found on both the Pennines and the North York Moors (Table 3). However, there was some indication that *Platybunus triangularis* and *Oligotrophus palpinalis* may be more widespread on the North York Moors than on the Pennine moors, where they were taken at only two sites.

Mitopus ericaeus was almost as widespread as *Mitopus morio* on the upland sites but at no site was it more abundant than the latter species. We expect that *M. ericaeus* will be found to be widespread in upland areas of Britain. So far it has not been recorded outside of the British Isles.

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BOOK REVIEWS

A Synoptic Classification of Living Organisms edited by **R. S. K. Barnes.** Pp. ix + 273. Blackwell. £7.50, soft cover.

The living world is so diverse that even the best naturalist or biologist can be familiar with only a minute fragment of it and, even if he has a general idea of where in the scheme of things a particular organism might belong, he cannot be expected to know just where each one fits. Likewise, from time to time one encounters unfamiliar group names in the literature and would like to know to what sort of organisms these refer and to which others they are related. Comprehensive treatment of such matters would require many large volumes but as the result of the commendable efforts of the authors of this compact conspectus of organic beings, one can quickly look up something about the Acanthobdellida, Amblypygi or Pyrosomida (how many could place these without hesitation?) and the 746 other orders to which living organisms are here assigned. A brief description of the salient features of the higher categories is in each case followed by shorter diagnoses of taxa down to ordinal rank, except for some of the vertebrate classes that are treated only down to the level of superorder. Extinct groups are not included.

Universal agreement on classification or definitions cannot be expected and it is easy to find some diagnoses with part of which one disagrees, or which may even be wrong on certain points. For example it is not surprising that members of the class Osteichthyes (i.e. bony fishes) are 'fish-like' (fishes are so diverse that such a description is in any case almost meaningless), nor is it helpful to be told that members of some superorders are teleosts when 'teleost' is not defined. Nevertheless a sample of groups with which I have at least some familiarity (no-one could comment authoritatively on them all) suggests that this will be a useful guide not only to present-day students of biology who, perhaps because of the way biology is going, often show a lamentable ignorance of the diversity of nature, but to the general naturalist to whom the plethora of group names that he encounters may sometimes be disconcerting.

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RECENT RECORDS OF ALIEN CRABS IN BRITAIN

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Recently, Wall and Limbert (1983) outlined the events relating to the capture and eventual escape of a Chinese Mitten Crab *Eriocheir sinensis* taken from Southfields Reservoir in Yorkshire. They comment that this is the second record for the British Isles and 'remains the only Yorkshire instance of this alien species being reported'. Although this is a unique county record, there have been several subsequent finds of *Eriocheir sinensis* from South Humberside and from the Thames. This note reviews these reports, and establishes a new record of the American Blue Crab, *Callinectes sapidus*, from the River Trent.

Mr B. Harrison, of Burton upon Stather, near Scunthorpe, first observed *E. sinensis* during the Summer of 1976 in the River Humber close to the outlet of the River Ancholme, and has seen this crab in the same area in subsequent years. During August 1979, Mr D. Mouney, from South Ferriby, South Humberside, found a Mitten Crab in one of his eel-nets near the sluice gates where the River Ancholme enters the Humber. A further specimen was recorded from the R. Ancholme in June 1984. Both specimens are preserved in the Crustacea Section of the British Museum (Natural History), presented by Dr B.E. Barnett (Anglian Water Authority) who provided the above details. Since Ingle and Andrews (1976) published their note on the reappearance of the Mitten Crab in the Thames, Mike Andrews (Thames Water Authority) has collected sixteen specimens from the river, ten from the screens of the Central Electricity

Plate 1. The Chinese Mitten Crab, *Eriocheir sinensis* collected by Mike Andrews from West Thurrock Power Station. Note the conspicuous 'hairy mittens' on the claws. (Bob Ivison BM(NH) Photo Unit). Carapace width = 65 mm.

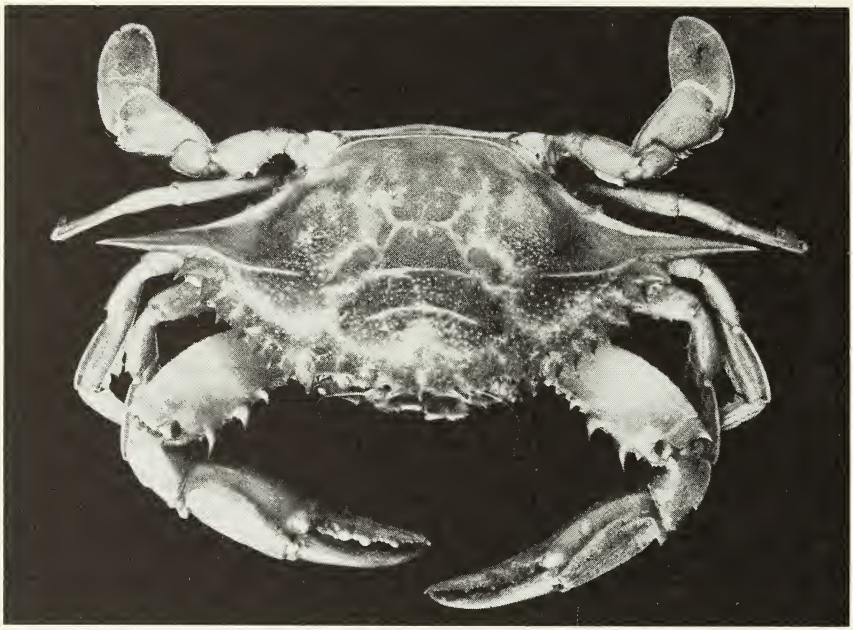

Plate 2. The Blue Crab, *Callinectes sapidus* caught by Ian Stancer in the River Trent. Note the long lateral spine on the carapace and the paddle shaped last walking leg. (Bob Ivison BM(NH) Photo Unit). Carapace width = 139 mm, including lateral spines.

Generating Board's West Thurrock Power Station, one from Regent's Canal Dock entrance and five from the Teddington Lock area.

The most recent alien crab to reach Britain is the Blue Crab (*Callinectes sapidus*) from America — range Nova Scotia to Uruguay. The Blue Crab has already been introduced to France, Netherlands, Denmark, Germany, Italy, Greece, Turkey, Lebanon, Israel and Egypt. Ingle (1980:89) established the first and only other British record, from a specimen trawled in the East Channel sea area, one mile off Littlestone-on-Sea, Kent, during September 1975. The latest and more significant report is the capture of a male from Dunham Bridge, approximately thirty-eight miles up the River Trent, by Ian Stancer, a Rotherham angler participating in a fishing competition on 18 August 1982.

This note and the accompanying photographs are intended to draw attention to the two alien crabs, *Eriocheir sinensis* and *Callinectes sapidus*. Details of future collections or sightings would be appreciated (date of capture, locality with map reference, name and address of collector). Live or preserved specimens would be especially welcome. Please pass information to me at the address given above.

References

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AN UNRECORDED 19TH-CENTURY CAPTURE OF *ECHINORHINUS BRUCUS* (BONNATERRE, 1788), A FORMER RARE VISITOR TO THE NORTH SEA

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The Spinous or Bramble Shark *Echinorhinus brucus* (Bonnaterre, 1788) is a species of tropical and (warm) temperate waters in the Atlantic, the Mediterranean, the eastern Pacific and the western Indian Ocean (Wheeler, 1978). In the seas of north western Europe it is a very rare visitor and an exceptionally rare one in shallow waters like the North Sea. In the latter area it has most often been caught in Yorkshire and Scottish coastal waters.

Apart from British literature, the species is also included in the standard work on Belgian marine fishes (Poll, 1947) on the evidence of a specimen caught in the North Sea and landed in Ostend. This author considered it to be very rare in the North Sea and at that time unrecorded from the Belgian coast. Consultation of the original reference by Van Beneden (1894) revealed that the shark landed at Ostend had been acquired by Gilson, then a teacher in natural history at the athenaeum (State Grammar School) of Ostend and later director of the Musée Royal d'Histoire Naturelle de Belgique (now the Koninklijk Belgisch Instituut voor Natuurwetenschappen) at Brussels. Gilson (1921) himself did not give any further details in his popular guide to fishes: '. . . rarely taken in the North Sea; more often in the English Channel and on the Atlantic coasts of France, Spain, Portugal . . .' (my translation).

Recently I found an old press-cutting containing considerable details of the occurrence. It was pasted into an old catalogue in the Museum of Zoology, State University, Ghent, facing the page with the registrations of some anatomical preparations of this species. The original account, published in the 'Etoile belge' of 29 January 1983 reads as follows:

'Nous apprenons que le directeur de la minque d'Ostende vient de faire don au musée de zoologie marine de l'athénée d'Ostende d'un poisson très rare, importé ici par un chalutier français, le n° 22, patron Léon Toutain, de Trouville. C'est le squale bouclé. Sa couleur est d'un gris foncé à reflets violacés et son corps est parsemé de taches noirâtres irrégulièrement disposées. Sa peau est recouverte de tubercules épineux assez saillants, blanchâtres et disposés par groupes, de telle sorte que certaines étendues de la peau en sont privées. Sa taille est de 2m70.

'Ce squale vit dans les eaus peu profondes; il est assez commun dans la Méditerranée; il est rare sur les côtes françaises de l'Atlantique et plus rare encore dans la mer du Nord. Celui dont nous nous occupons a été pêché près du Gallopes, banc situé près des côtes anglaises, un peu au sud de Yarmouth. La chair du squale bouclé est de mauvais goût.'

The text speaks for itself. Thanks to this article I was able to find the stuffed skin of the specimen, still present at the school in Ostend.

There can be no doubt that the registered anatomical preparations were made from this same animal. They too are still preserved in the old collection of the Museum of Zoology. They comprise the heart (RE 2546), the brain (RE 2547), an eye (RE 2548), the shoulder girdle (RE 2549), the male urogenital system (RE 2550), some vertebrae (RE 2551), a longitudinal (RE 2552) and a transverse (RE 2554) section of vertebrae, and another with special emphasis on the neural arch (RE 2553). They were entered in the catalogue during 1893.

There is some disagreement about the length of this specimen. The newspaper report probably means that the species can grow to 2.70m or else it is a misprint for 1.70m. A footnote in the catalogue says it was 1.75m long. According to Gilson (1921) it attains only 1.50m. The stuffed skin measure 1.57m. Taking into consideration the likely shrinkage of the nearly

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one-century-old skin, the length given in the footnote must have been close to the real length.

It is clear that *Echinorhinus brucus* has never been recorded along the Belgian coast, as the Galloper Bank lies in English coastal waters. The present record however is an interesting addition to our knowledge of the species' former occurrence in the North Sea. Chances to meet it nowadays in the area indeed are small to none. There were several records in the nineteenth century around the British Isles but very few this century and none in the North Sea. In the last two decades it has been recorded once only, in August 1969 near Cornwall (Wheeler & Blacker, 1972). For this reason it is important to draw attention to the present specimen which appears to have been the most recent capture in the North Sea. Other occurrences in that area are listed.

1830, summer, Filey Bay, Yorkshire (54°10′N)
1836, 11 August, Bridlington Bay, Yorkshire (54°05′N)
1851, January, Gamrie, Moray Firth (57°45′N), 1.80m
1853, June, Scarborough, Yorkshire (54°15′N)
1869, ——, mouth of River Tyne (55°00′N)
1873, July, mouth of River Ythan, Aberdeenshire (57°20′N), 2.25m
1876, July, mouth of River Tyne (55°00′N), 1.80m
1883, 31 August, 14 miles N of Aberdeen (57°20′N), 2m
1886, June, 50 miles off Whitby, Yorkshire (54–55°N), 3-3.60m
1893, c. 15 January, Galloper Bank, Suffolk (51°45′N), 1.75m.

The Belgian specimen is special in two other respects. Firstly, it represents the most southern occurrence in the North Sea. Secondly, it is one of only two occurrences recorded in winter (the 1851 record being the other).

Echinorhinus brucus lives near the bottom in rather deep water, between 400 and 900 metres. According to Bauchot & Pras (1980) it shows a summer migration to shallower waters, between 20 and 200m. The observed seasonal pattern in the North Sea, with most occurrences between June and August, fits well into this picture. It is obvious from the data that for most of the North Sea captures the sharks entered by the north, migrating along the continental shelf into shallower water. The southern Galloper catch is somewhat enigmatic. It could equally well have entered the North Sea by the deep water channel running northward from the English Channel, as a continuation of it. The species is known to have been captured several times in the latter area too.

Finally we wish to express the hope that the stuffed specimen can be acquired by a scientific institute. It is probably the only preserved animal of NW-European origin in Belgium and is thus of considerable importance.

We wish to thank Mr A. Wheeler (BMNH, London) for providing information on the former occurrences in the North Sea, F. Kerckhof (Ostend) for contacting his former school, and Dr J. Govaere (KBIN, Brussels) for help with old literature.

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A POPULATION STUDY OF SWALLOWS IN EAST LANCASHIRE

J. NUTTALL

This paper gives details of a population study of Swallows, *Hirundo rustica*, around the village of Worsthorne-with-Hurstwood, near Burnley, Lancashire.

The study area is a rectangle approximately 7.5 square miles in area, centred on the village. Altitude varies from 500 ft in the west rising to 1000 ft at the eastern boundary. The land is mainly used for dairy farming, with hill farming in the east. Several small deciduous woods are dotted throughout and there is one coniferous plantation. Three small rivers, the Brun, the Don, and Swinden Water, flow through the area. There are five reservoirs, three of them above the 900 ft contour.

Method

All the farms within the area were visited before the study began in 1973. Several had to be left out of the survey because of the farmer's objection to any bird study around his buildings. All the rest were inspected annually, even where there appeared to be no suitable buildings for Swallows or where the birds were actively discouraged by blocking of access holes.

After the study began, some farmers reversed their opposition and permitted visits. Two farms changed hands and the new owners were in complete agreement with the project. Ultimately, there were only six farms not included in the survey, and I estimated that this would involve a loss of no more than 4 pairs, or about 7 per cent of the total breeding population in the area.

The young Swallows were ringed as nestlings. With the adults, mist-nets to catch them as they left the buildings proved the best method. No attempts were made to catch females at the nest, and all netting was confined to the time after the young had hatched.

Distribution

The Swallow population of 36 farms was studied. The number with Swallows present varied very little from year to year in the period 1973–1981 inclusive, about 28 being normal. Settlements averaged about 1.7 pairs at each, the maximum total being 54 pairs over the whole area, 1980.

Re-traps

360 adults were ringed in the eight years 1973–80. A high proportion of birds were caught for the first time in every year. Twenty-seven birds (14 males, 13 females) were caught and re-trapped at the same place in subsequent years. One of these, a male, was the oldest bird recorded in the study, being at least eight years old in 1981.

Six birds (5 males, 1 female) were ringed at one site but re-trapped as breeders at another the following year. In each case the original farm was checked for any reason that might have caused the move, but in only two had there been any structural alterations to explain it. The movement of the female had no obvious cause, and her mate from the previous year was back on his usual pitch. All these movements were within one mile. Three pairs were recorded as breeding together in more than one year. Two of these were together for two consecutive years, the other for three. One pair together in 1978 returned in 1979, but each took a new partner and nested in a different building from where it had been in 1978.

Ringing of Nestlings

1,111 nestlings were ringed between 1976 and 1980 inclusive. A mere 21 of these (12 males, 9 females) were re-trapped in the study area as breeders, 13 of them as one-year-old birds, 8 as two-year-olds. Only one nestling was recorded breeding at the farm where it was hatched. Two others were reported as breeding outside the study area, one 8 miles away and the other just outside the boundary.

Morphology of Adults

Wing measurements of females varied from 116 mm to 132 mm, males from 122 mm to 133 mm. Sex was determined by measuring the length of the tail streamers, and also the distance from the tip of the primaries to the tip of the tail streamers. Males' tail streamers varied from 25 mm to 55 mm, females from 5 mm to 31 mm.

Breeding Performance

The clutch sizes were recorded at 105 first-brood nests which produced 465 eggs; of these nests, 100 were successful and 435 chicks fledged. It was noted on several occasions that some adults raised only one brood, and then left. These birds were not caught.

176 second-brood nests were examined, with a total of 717 eggs. 167 of these nests were successful, and 670 chicks fledged. Human interference was almost the only cause of failure. The mean clutch-size for first and second broods was 4.57 and 4.07 eggs respectively, approximating closely to the collective figure of 4.4 eggs found by earlier workers in north-west England (Boyd, 1936, Adams, 1957). The average number of young fledged from first and second broods was 4.35 and 4.0 per nest respectively, again correlating closely with previous findings.

Migration and Ringing Recoveries

Migration-routes of the fledglings out of the area are indicated by the re-trapping of nine elsewhere — four to the east, 33–100 km away, five to the west and south-west, 13–42 km distant.

Two rings from chicks from the same nest were subsequently found in local Tawny Owl *(Strix aluco)* pellets.

In 1980, for the first time, two nestlings that had been ringed during June were re-caught and released whilst roosting away from their natal farm. The first was one mile east, the second two miles west.

Three birds ringed as juveniles at other stations were subsequently trapped in the study area, and, of course, released again. Two were breeding; one was caught at roost. They had been ringed at Brough, Spurn Point and Huddersfield on southbound migration in previous years.

References

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NOTE: The above paper is a summary of a longer and more detailed script by the late John Nuttall, who died on 17 November 1982. The statistical information on which it is based, plus the original text, has been deposited with the British Trust for Ornithology, Beech Grove, Tring, Herts.

ENTOMOLOGICAL REPORTS FOR 1973-83

J H FLINT

Coleoptera: part 1, carabidae

This report covering the period 1973-83 is the first to appear since that for 1972. A mass of records covering the period has been received; those not known to be common and widespread have been entered in the YNU records and a selection comprising the more notable new localities and confirmations of old ones is listed below. The report will appear in parts and the first deals with the ground beetles (Carabidae).

Study of the ground beetles received a fresh impetus with the inauguration of the 10 km mapping scheme by Dr M. L. Luff. The more detailed work on distribution which ensued

revealed that one beetle (*Dromius angustus*), formerly unknown, is actually widely scattered across the county and others thought to be of very restricted occurrence are also widespread. New members have taken up the study and their work in areas that were previously little visited has produced some remarkable discoveries. An outstanding example is that of Mr M. L. Denton whose work, especially in the Elland gravel pits, has turned up some quite surprising beetles for the locality and the habitat.

In the list that follows, statements about distribution and occurrence refer to Yorkshire unless clearly stated otherwise and it is hoped that further work and more reports to the recorder may be encouraged. My thanks are due to all contributors. Initials used are those of the following: R. Crossley, M. L. Denton, W. A. Ely, Mrs H. E. Flint, J. H. Flint, P. W. H. Flint, P. Kendall, Canon T. B. Kitchen, Dr B. J. MacNulty, R. J. Marsh, K. G. Payne and P. Skidmore.

Carabus glabratus s. *lapponicus* Born (65) Stainton Moor, 28/5/78; one running in hot sunshine on a narrow sheep trod among the heather; H.E.F. There are scattered records from the N.E. moors and an old record from Ingleborough; it has also been reported in numbers running in hot sunshine on the slopes of Mickle Fell.

C. monilis F. (62) Levisham, running in hot sunshine, 6/77; J.H.F. Less frequently reported than formerly, much less frequent than *C. nemoralis* Mull.

C. nitens L. (62) Pockley Moor, three; Bilsdale East Moor, eight; (64) Denton Moor, Otley; (65) Fremington Edge; Stainton Moor, seven; Askrigg Common. R.C., H.E.F., J.H.F., B.J. MacNulty. Recorded from upland moorland areas and the three lowland heaths, Allerthorpe, Skipwith and Strensall. In all but one case above the beetles were found running in warm sunshine over bare ground. A reputed method of finding them by trampling through *Sphagnum* bogs has never yielded one to us.

Calosoma inquisitor (L.) (65) Frost Row Fell, 3/6/77; A. Kinnisburgh per P.W.H. Flint. The only other Yorkshire record was from flood refuse at West Tansfield in 1968.

Leistus spinibarbis (F.) (61) Houghton Wood, Market Weighton, 23/9/72; R.C. Favours sandy, mossy ground in woods.

L. rufomarginatus Duft. (*62) Duncombe Park, Helmsley, one under beech bark, 30/9/80; P.S. Previously reported in Yorkshire (63) at Wickersley Wood (Ely, 1980) and near Agden Reservoir (Bird, 1982). Helmsley appears to be the most northerly station attained by this beetle in its northward spread.

Nebria livida (L.) (61) Fraisthorpe, 7/9/80; J.H.F. Barmston Drain, 1982; T.B.K. Formerly recorded regularly from cracks in the clay cliffs from Scarborough to Spurn; now rarely found.

Notiophilus aestuans (Mots.) (*61) Spurn, 4/9/82; M.L.D. (*64) Hawkswick Moor, Littondale, 7/76; J.H.F. (65) Fremington Edge, Reeth, 19/5/74; Apedale, near Castle Bolton, 18/5/75; Gunnerside Gill, 22/4/76; Harkerside Moor, 17/7/76; J.H.F., H.E.F. Since its discovery in the North of England on Stainton Moor in 1972 (Flint, 1977b) all other sites in Yorkshire until that at Spurn have been in the lead mine spoil heaps of the Yoredale rocks where the beetles run over the bare gravel surface and hide under tufts of *Minuartia verna*.

N. germinyi Fauv. (*61) Hunmanby Gap, on sea cliff, 8/7/72; K.G.P. Most commonly found on upland moorland, scattered records on lower ground.

N. quadripunctatus Dej. (63) Elland gravel pits, 25/9/83; M.L.D. Only four times previously in Yorkshire, widely scattered.

N. rufipes Curt. (*61) Skipwith Common, 4/5/80, two in pitfall traps on mossy ground under oaks; J.H.F. (*62) Castle Howard, in leaves under beech, 6/8/60; K.G.P. (63) Bretton Park, 11/2/82; M.L.D.

Blethisa multipunctata (L.)(63) Potteric Carr, 11/6/83; M.L.D. Widely scattered across the county but rarely found.

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† New county records. * New vice-county records.

Dyschirius aeneus (Dej.) (61) Faxfleet, 3/6/78; J.H.F. Allerthorpe Common, 14/10/79; R.C. (63) Thorne Moors, 20/5/72; W. Bunting jnr. (det. P.S.). Following the separation of *D. luedersi* from *D. aeneus* earlier records are not reliable. An early assessment of distribution is that *D. luedersi* is at least as frequent as *D. aeneus* in Yorkshire; no difference in habitat has yet been noticed.

D. luedersi Wag. (63) Askern, 22/6/75; J.H.F. Thorne Moors, 17/8/75; Fishlake, Doncaster, 3/7/76; Blacktoft Sands, 17/7/76; R.C. Swinefleet, 28/5/78; P.K. (64) Carlton, Snaith, 16/7/77; J.H.F.

Aepus robini (Lab.) (62) Cayton Bay, in rock crevices below high tide on Gristhorpe Nab, 6/9/81; J.H.F.

Trechus rivularis (Gyll.) (64) Askham Bog. Since its discovery here in 1965 by E.W. Aubrook it has been found regularly at the base of grass tufts and in heaps of grass and reed litter.

T. rubens (F.) (62) Raindale, Newtondale, 8/7/75, in numbers, flying at sunset on a warm evening; H.E.F. (63) Crag Vale, 3/6/79; M.L.D. Ogden Clough, 9/7/83; P.K. (64) Timble Ings, Otley, 22/5/79; R.C. (*65) Summerlodge Moor, 7/6/75, in flight at evening; J.H.F.

T. subnotatus Dej. (63) Netherton, 20/11/83; M.L.D. (*teste* M.L. Luff). Apart from two earlier records from Huddersfield the only others known in Britain are four records from Devon.

Bembidion obliquum Sturm (*65) Bedale, 17/7/82; W.A.E.

B. varium (Ol.) (61) Stone Creek, Humber estuary, 7/6/80; J.H.F. (*63) Blacktoft Sands, 17/7/76; R.C.

B. prasinum (Duft.) (63) Ogden Clough, 9/7/83; P.K.

B. geniculatum Heer (61) Sewerby Cliffs. (62) Sandsend; Wheeldale Moor. (63) Langsett; Blake Dean, Halifax; Elland gravel pit. (64) Great Whernside; Burley Moor; Farnham gravel pit; Thruscross; Blubberhouses; Pateley Bridge. (65) Cautley Spout. Formerly considered rare, it is now seen to be widespread on shingle beside streams in the moorland and also where streams cut through shingle and clay on to the seashore.

†*B. fluviatile* Dej. (64) Ben Rhydding, Ilkley, on sandy river bank, 2/6/73, 2/6/74; R.C. Farnham gravel pit, Knaresborough, 1/7/76; R.C.

B. maritimum Steph. (63) Fishlake, Doncaster, 3/7/76; Blacktoft, among debris at the edge of sedge beds, 7/7/76; R.C. Boothferry Bridge, 25/6/77; J.H.F.

B. monticola Sturm (*63) Elland gravel pits, 8/10/80; M.L.D.

B. saxatile Gyll. (*63) Broomhead reservoir, 2/9/79; M.L.D.

B. stephensi Crotch (*63) Elland gravel pits, 16/3/80; M.L.D. Widely scattered but scarce and mainly coastal.

B. testaceum (Duft.) (*64) Farnham gravel pits, 1/7/76; R.C.

B. humerale Sturm (63) Thorne Moors. R. Crossley and A. Norris independently each discovered single examples on the muddy margin of a pond in the peat at Will Pits, 17/8/75, the first in Britain (Crossley, 1975, 1976). Subsequently R.C. found it to be common and widespread over much of Thorne Moors where it usually occurs on bare, damp peat with scattered vegetation, tufts of grass and heather, under which it often is concealed. Dates range from 15th April to 10th October. Not yet known elsewhere in Britain.

B. assimile Gyll. (*63) Thorne Moors, 17/8/75; R.C. Sprotborough Flash, 3/11/78; Rushy Moor, 21/6/83; R.J.M. Elland gravel pits, 3/12/83. All previous Yorkshire records are coastal; Spurn, Hornsea, Saltburn.

B. fumigatum (Duft.) (63) Goole Moors, 1/5/76, in *Phragmites* litter; Will Pits, Thorne Moors, 28/6/78; R.C. Rushy Moor, 21/6/83, in sedge litter; R.J.M. Withens, Halifax, 24/8/80; Elland gravel pits, 3/12/83; M.L.D. Estuarine sedge litter is a typical habitat; these records extend the habitat inland considerably.

B. minimum (F.) (61) Brough, 29/7/72; R.C. Cherry Cob Sands, 7/9/80; J.H.F. North Ferriby, 18/6/77; K.G.P. (*63) Blacktoft Sands, 26/4/75; Boothferry Bridge, 25/6/77; J.H.F. (*64) Moor Monckton, 29/12/79; R.C.

B. iricola Bedel (61) Brough, 29/7/72; R.C. North Ferriby, Humber shore among *Phragmites* litter, 18/6/77; K.G.P. Stone Creek, 7/6/80; R.J.M. Previously known from Spurn and Ousefleet, it is likely to be found in litter all along the Humber.

Pterostichus aethiops (Panz.) (62) Harwood Dale, 25/1/82; J.H.F. (64) Penyghent, at 1,750 ft., 13/3/77; J.H.F. (65) Buttertubs Pass near Hawes, 2/9/75; H.E.F. Under stones on upland grassland but not otherwise reported since 1920.

P. angustatus (Duft.) (*61) Houghton Wood, Market Weighton, 23/9/72; North Cliffe, 24/9/77; Skipwith Common, 14/10/79; R.C. (63) Netherton, 17/12/83; M.L.D. (64) Morton Bog, Selby, 12/9/64; K.G.P. Beecroft Moor plantation, Blubberhouses, 15/7/78; Timble Ings, 12/8/79; R.C. First found in Yorkshire in Leeds in 1939 it has now successfully established itself in widely scattered localities across the county.

P. cristatus s. *parumpunctatus* Germ. (*65) Gilling Park, Richmond, 25/6/77, one under a stone at the bottom of a steep rill, without water but still damp; K.G.P. Previously reported from Ingleton, c.1948, by A. de Porochin, the British population is centred on the Tyne valley.

P. gracilis (Dej.) (61) Wheldrake Ings, 14/2/76; J.H.F. Bubwith, flood refuse, 29/1/77; R.C. A marshland beetle known in the Bubwith area since 1915, the only other record being a very old one from Hornsea Mere.

Calathus ambiguus (Payk.) (62) Strensall Common, 15/4/73; J.H.F. Very scarce now; there are only two other reports, the last in 1935.

Platyderus ruficollis (Marsh.) (61) Sewerby, under chalk pebbles at the base of the cliffs, 19/5/75; R.C. Previously reported from Bridlington in 1901, there is only one other record in the past 80 years.

Agonum ericeti (Panz.) (62) Ewe Crag Slack, Gerrick Moor, 4/6/83; J.H.F. (*63) Thorne Moors, 14/4/73; R.C. (64) Austwick Moss, 1/6/79; J.H.F. On very wet ground beside *Sphagnum* bogs.

A. livens (Gyll.) (*61) Wheldrake Ings, 7/2/76; J.H.F. (63) Thorne Moors, 5/75; R.C. Shirley Pool, 7/4/83; R.J.M. The northern limit of its British range.

†*A. quadripunctatum* (Deg.) (62) Seamer, 9/51; E. F. Gilmour (*teste* M.L. Luff) per P.S.

Amara convexior Steph. (*64) Timble Ings, 10/5/80, a male in a pitfall trap; R.C. (det. M.L. Luff). Only previously at Esholt (VC63) 1890.

A. praetermissa (Sahl.) (*61) Holme upon Spalding Moor, 5/7/81; M.L.D. (*63) Bradley Mills, 26/7/80; M.L.D.

Harpalus puncticeps Steph. (61) Filey Brigg, 18/9/83; H.E.F. (det. J.H.F.).

H. rubripes (Duft.) (61) Fordon Bank, 9/8/73; J.H.F. (62) Ellerburn Bank, 13/5/73; J.H.F. (63) Moorends, Thorne, 31/7/76; R.C. Cold Edge Dam, Halifax, 31/7/81; M.L.D. Rushy Moor, Askern, 21/6/83; R.J.M. (64) Grafton, sand quarry, 24/6/77; J.H.F.

H. tardus Panz. (63) Hatfield Lings, 23/4/77; J.T. Burn (*teste* P.S.).

Anisodactylus binotatus (F.) (*63) Thorne Moors, 23/5/75; R.C. Elland gravel pits, 16/8/80; M.L.D.

Bradycellus sharpi Joy (*63) Elland gravel pits, 4/4/76; R.C. (64) Bishop Wood, 10/11/74; J.H.F. Wilstrop Wood, 28/2/76; R.C.

Acupalpus consputus (Duft.) (*63) Will Pits, Thorne Moors, 28/6/78; R.C. There are only two other Yorkshire records.

A. dubius Schil. (61) Hotham Carrs, 24/3/73; R.C. (*62) Strensall Common, 11/11/78; R.C. (63) Thorne Moors, 12/3/73; R.C. Rushy Moor, 27/9/83; R.J.M. Potteric Carr, 11/6/83; Elland gravel pits, 8/10/80; M.L.D. (64) Dunsforth, singly, 1976-1979; R.C. Evidently much more widespread than the paucity of earlier records indicated.

Badister sodalis (Duft.) (63) Thorne Moors, 26/4/75; R.C. Worsborough Reservoir, 17/5/80; M.L.D.

B. unipustulatus Bon. (*63) Hook Moat, near Goole, 31/5/75, 3/5/76, 21/5/77, on the banks of R. Ouse; P.K. The only previous record is Hull, 1807.

Chlaenius nigricornis (F.) (61) Wheldrake Ings, 28/12/82; J.H.F.

C. vestitus (Payk.) (61) Sewerby, at the base of the cliffs, 19/5/75; R.C. Taken here at intervals of time, this seems to be the most persistent colony.

Lebia chlorocephala (Hoff.) (62) Sandsend, one specimen by grubbing among grasses on sandy cliffs, 30/8/78; R.C. Old records are widely scattered and it has not been reported since 1939.

†*Dromius angustus* Brullé (61) Skipwith Common, 13/10/74, by beating Scots Pine (*Pinus sylvestris*), subsequently under pine bark (Flint, 1977a). (62) Strensall Common, 3/11/74; Towthorpe Common, 24/11/74; Lowna, 6/3/77; Pockley, 10/77; Roppa Bank, Rievaulx Moor, 31/12/77; J.H.F. Strensall Common, dozens beaten from branches of old pines, 30/5/83; K.G.P. (63) Sandall Beat Wood, beaten from Scots pine, 30/6/82; P.S. (64) Golden Acre, Leeds, 29/12/77; Beckwithshaw, 31/12/77; J.H.F. The first records for the north of England, it has since been taken in Lincolnshire (Stapleford Moor Wood) and Nottinghamshire (Clumber); J.H.F. In winter they hibernate under the loosely flaking bark of old pines, usually, but not invariably, on the sunny side of trees with an open aspect to the south, often in company with *D. agilis* (F.). When disturbed they drop very quickly to the ground, much more actively so than does *agilis*.

D. longiceps Dej. (*61) Broomfleet Island, 18/6/77; R.C. (63) Swinefleet, 28/5/78; P.K. Blacktoft is the only other known site.

D. notatus Steph. (61) Flamborough Head, 1/11/81; M.L.D. (62) Scarborough, 31/10/80; M.L.D.

D. sigma (Rossi) (63) Elland gravel pits, 8/10/80; M.L.D. A significant extension of the known range of this fenland beetle of which the other Yorkshire colonies are at Askham Bog and Thorne Waste. There is an old record for Throxenby Mere, Scarborough.

Metabletus truncatellus (L.) (61) Barmby Moor, on bare sandy ground, later ploughed out, 22/5/77; J.H.F.

Cymindis vaporariorum (L.) (62) Rudland Rigg, a single example running on the ground, 19/9/76; J.H.F. May Moss, 19/6/82; P.K. A moorland beetle found in the north-east and south-west of the county, rarely seen and not otherwise reported since 1923.

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BOOK REVIEWS

Eric Hosking's Birds: Fifty Years of Photographing Wildlife by **Eric Hosking** with **Kevin MacDonnell** (foreword by **Roger Tory Peterson**). Pp. 224. Pelham Books: London. 1983. £7.95.

This is the paperback version of a book first published in 1979 to celebrate Eric Hosking's golden jubilee as a professional bird photographer. The doyen now of his craft, with that exceptional ability to make his subjects appear to be posing naturally before the camera, he collects here some 280 of his finest pictures, in both colour and black and white. They include old favourites and new splendours: the Vesta Swan, the Tawny Owl that robbed the author of an eye in 1937, the newly-fledged cuckoo chick removing the other eggs from its nest, that proud kingfisher with a fish dangling from its bill, waders massed on Hilbre Island, and so on. The accompanying text takes us from Hosking's first struggles with a Sanderson Field Camera to his

latest electronic gadgetry with an Olympus, and reveals how new techniques are always being pioneered by this master without any loss of the excitement still aroused in him by the birds he is now photographing the world over. He remains a keen observer of bird behaviour, whether in his north London garden or in the Galapagos Islands, as many of his pictures and the lively, anecdotal and wide-ranging text of this book together show. Technical details are added on each photograph, and Hosking makes no secret of his use from time to time of aviaries and zoos. Others use the same films and comparable equipment; others too share something of his knowledge, experience and patience; few have equalled his ability to portray birds, especially in flight. Let all, however, heed Hosking's first commandment: in bird photography, the bird's own welfare must always come first.

WGA

The Moths and Butterflies of Great Britain and Ireland edited by **John Heath** and **A. Maitland Emmet.** Volume 10, Noctuidae (Cuculliinae to Hypeninae) and Agaristidae. Pp. 429 with distribution maps and text figures, plus 13 colour plates. Harley Books. 1983. £40.

Although the volume under review is number ten of a planned series of eleven (the last to be devoted to larvae), this is only the third to be published of this major work. This is, I believe, the only really comprehensive series to be published which will include all the lepidoptera, macro- and micro-, which have occurred in the British Isles up to the present time.

It is good to see a series on lepidoptera (unlike *The Moths of the British Isles,* 1961) brought really up to date on distribution. This is aided by the species distribution maps on a 10 km square system compiled by the Biological Records Centre of ITE. However, the maps, though good for most species, are not always accurate for others (especially the critical species) as the Biological Records Centre has, I believe, been too willing to accept records from inexperienced observers without confirmation. For example, *Hoplodrina ambigua* (Vine's Rustic) and *Conistra rubiginea* (Dotted Chestnut) have rarely been reported north of the Thames, but the former is shown as occurring in two distinct areas of Cumbria and even in Scotland. As I have contacts with Cumbrian lepidopterists these records seem unlikely, as also do the northern records for *C. rubiginea* in Northumberland. On the other hand, *Cosmia affinis* (The Lesser-spotted Pinion) is more common in Yorkshire than is apparent from the map. I personally have found larvae, and bred the moths, from five localities in central Yorkshire (VCs 61, 62 and 64). Furthermore, many species which are stated in the text to be widespread in Ireland have only a few 10 km squares marked. Though many colour plates are good, others leave something to be desired, especially plate 2, in which the bodies appear to be more slender than they actually are in most species. They are certainly inferior to the plates in *British Pugs* (1981) or to earlier editions of South's *Moths of the British Isles.*

This book caters for the beginner by pointing out differences beween 'similar' coloured species, such as *Moma alpium* and *Dichonia aprilina,* as well as for the specialist with its detailed drawings of genitalia of critical species.

To sum up, this series, including the volume reviewed here, must be quite the best ever published which is to include the whole of the British lepidoptera. It will be useful and informative to amateur and professional alike, though the high price is likely to be beyond the reach of the younger enthusiast.

SMJ

The Dragonflies of Great Britain and Ireland by **Cyril O. Hammond.** 2nd edition, revised by **Robert Merritt.** Pp. 116, with 20 colour plates, 23 figures and 44 maps. Harley Books, Great Horkesley, Essex. 1983. £16.95.

The first edition was very favourably reviewed in these pages in 1978 and that review concluded, 'Here is a book that will enable any student to name reliably all the British dragonflies.' It is pleasing to welcome this new edition which makes some minor alterations to the introduction and to the keys, and brings the 10 km maps up to date. A sign of the times is the addition of two pages on conservation. The principal addition is that of *Coenagrion lunulatum,* discovered in Ireland in 1981. The printing retains its very high standard.

JHF

Genetic Engineering in Higher Organisms by **J. Roger Warr.** Pp. 58, with diagrams. Studies in Biology no. 162. Edward Arnold. 1984. £2.85, paperback.

The Genetic Code and Protein Biosynthesis by **Brian F. C. Clark.** 2nd edition. Pp. 76, with diagrams. Studies in Biology no. 83. Edward Arnold. 1984. £3.20, paperback.

A new title and two second editions are welcome additions to the Studies in Biology series. The new book *Genetic Engineering in Higher Organisms* is of particular interest to any biologist or student desirous of understanding the theory of modern gene manipulation techniques whereby DNA is transferred among organisms of different types, genes are cloned and human genes are mapped without the necessity of breeding experiments. The applicability of such aspects of applied biology in medicine and in plant and animal breeding is made evident, and this reviewer sought the word 'biotechnology', happily in vain.

The Genetic Code and Protein Biosynthesis brings an up-to-date view of a field where basic concepts have been modified since the mid-1970s when the first edition appeared. The universality of the Central Dogma of molecular biology was already being questioned at that time; since then (and among other matters) eukaryotic systems have proved more complex, the universality of the code has been questioned and special properties of bacterial and animal viruses have been recognized. This is a book for the non-specialist with a 'head for heights'; the difficult world of macromolecules is one to which the majority of biologists will never have direct access and of which they will probably understand little except for elegant oversimplifications such as the Central Dogma and its successors.

DJH

Flora of Connemara and the Burren by **D. A. Webb** and **Mary J. P. Scannell.** Pp. xlvi + 322 (including 25 black and white photographs and 2 maps), plus 4 colour plates. Cambridge University Press, in conjunction with Royal Dublin Society. 1983. £35.00.

Although internationally renowned for their botanical interest, Connemara and the Burren have never had a published flora. This authoritative work is therefore extremely welcome.

At first sight, the combination of these two regions, which do not follow exactly the lines of vice-county boundaries (the traditional basis for British and Irish floras), is unexpected; however, in practice this works quite well, since the botanist visiting western Ireland is able to contrast two different ecological areas, Connemara with a calcifuge flora and the Burren with a calcicole flora.

This is essentially a reference work, containing a wealth of ecological and distributional data; as such, it will be invaluable, but it will be of questionable use actually in the field (even if the owner were willing to subject his costly purchase to the notoriously damp climate of the west of Ireland!). Although no keys are provided (with the exception of a short one to the yellow composites), considerable useful taxonomic information is contained in the text, at family (eg Umbelliferae), at generic (eg *Carex*) and at specific levels.

Sections dealing with topography, geology and soils, climate, character of the flora, habitats, history of the flora and other plant groups are also provided, but these tend to whet rather than satisfy the appetite; more extended treatment of some of this matter, particularly that on habitats, would have been preferable. Many of these important sections are unfortunately treated as preliminaries paginated in Roman numerals, and the plant references contained therein (as well as those in the chapters on other plant groups) are not indexed. In general, the book is well produced, but the quality of the black and white photography is variable.

This flora will be a standard work for many years to come, and will stimulate many more botanists to visit these beautiful and botanically exciting regions.

MRDS

Get to Know the Forests of Northern England by **C. Maclean, J. Tindley,** and **S. Scott.** Pp. 143, with many monochrome photographs, maps and line drawings. Macdonald, Edinburgh. 1983. £4.95.

Forests provide a rich resource for recreation, among other things, but not unless you know about them. The authors of this book have endeavoured to provide information on a range of

forests north of a line running through Skegness, Newark, Nottingham, Ashbourne, and Chester. Not all forests are included, of course — only those open to the public, which in fact means mainly Forestry Commission properties.

The book begins by giving some very brief general information about forestry history, practice and wildlife, and then provides rather more detail about the forests themselves. The intending visitor is told how to get there, what facilities to expect (both in the forest and nearby), and some information about the main walks in the forest. Neat and clear maps of each forest are provided from the pen of Sue Innes, but only at the scale of one inch to the mile, which may not be detailed enough for many walkers. Forests are arranged in four geographical regions (each with a regional map), presumably to help you find those nearest to you, but the one nearest to the editorial offices of this journal (Lindley Moor in the Dales) was in fact included along with the Eastern forests although it lies in the West Section. Arrangement of the forests within the Sections is according to geographical proximity, whereas an alphabetical order might be easier to follow.

Monochrome photographs add interest, and there are line drawings of foliage and cones of the wide range of species visitors may find. These look nice, but are not really clear enough to be of much help in identification. The occasional slip (eg, labelling a Douglas fir cone as Norway spruce) does not help.

For ramblers interested in adding forests to their hikes, this is a very useful book, but if their interests extend to the trees themselves, or to forest wildlife, this is not the only book they will have to take with them when they go.

RLS

The Ecology of Algae by **F. E. Round.** Pp. vi + 653, many tables, figures and photographs. Cambridge University Press. 1984. £22.50, paperback.

A paperback version (first published in 1981) of a scholarly contribution to ecology, in which algae are rightly shown as important components of a wide variety of marine, freshwater and terrestrial ecosystems, including such habitats as open water, sediments, rocky shores, coral reefs, hot springs, sea ice and soil. Sections also deal with such topics as seasonal cycles, energy-flow, geographical dispersion, palaeoecology, symbiotic relationships, grazing in aquatic food chains and eutrophication.

Strongly recommended for students and teachers of phycology, limnology and marine ecology, both as a course text and as an outstanding reference work.

MRDS

Landmarks of Botanical History by **Edward Lee Greene,** edited by **Frank N. Egerton.** 2 volumes (pp. x + 505, 506-1139, with 281 figures). Stanford University Press. 1983. $100 the set.

These two edited volumes of the work of Edward Greene (1843–1915) are published for the Hunt Institute for Botanical Documentation (Carnegie-Mellon University). Part I was originally published in 1909 but has long been out of print, and Part II appears for the first time. New matter in the form of a biography of Greene (by Robert P. McIntosh), an evaluation of his contribution to botany (by Rogers McVaugh), and introductory matter by the editor has been added to Part I.

This is undoubtedly a scholarly work, tracing the history of western European botany and botanists from antiquity to the 18th century, and containing as it does a wealth of information, backed up by extensive notes and references. Greene singles out twenty-six botanists for detailed treatment, and this forms the major part of the work. Many of us, however, would cavil at his choice of the early Greeks and Romans, 15th century Italians and 16th century Germans as the sole, or indeed representative, 'landmarks' of botanical history. Fortunately, complementary information (albeit limited) has been provided by the editor to reflect the important contribution of other periods and countries (within and without western Europe) to pre-Linnean botanical knowledge.

The volumes are beautifully produced, being lavishly illustrated with line drawings of plants, title-pages and portraits from the major published works thoughout the period covered.

We are indebted to the publisher, editor and contributors for creating a reference work which is also a pleasure to peruse.

MRDS

Darwin and the Spirit of Man by **Sir Alister Hardy.** Pp. 245, with diagrams. Collins. 1984. £9.95.

Sir Alister Hardy is a neo-Darwinian, a zoologist, and a champion of Alfred Russel Wallace. The first seven chapters of his book, illustrated with 34 line drawings and diagrams, constitute a fine historical account of the development of evolutionary theory up to the present time. Plants, however, are passed over with scarcely a glance: Mendel used some, they provide 'surroundings' to which animals are adapted and they are bred. By chapter eight it is evident that consciousness, or even perhaps self-consciousness, which is ascribed only to animals, is related to the claim that 'naturalists of human experience' have provided 'an overwhelming demonstration . . . of a part of man's natural history that can only be described in spiritual terms'.

The subsequent five chapters are devoted mainly to spiritual matters; a link with evolution is suggested through a form of group selection by which primitive tribes with a tradition of belief in a god would harness a 'force to make them stronger, a something that gave more courage'. This belief would have survival value in that such tribes 'would more likely be successful in the struggle for life'. One wonders, in fact, whether such biological success should be ascribed to religious leaders rather than to the tribes manipulated by them. The phenomenon of faith is discussed, religious experiences (based on solicited testimonials) are categorized, and purpose in the universe is postulated, 'but to suppose that what we imagine *is* actually the real purpose would be the height of impertinence'.

Sir Alister's writing is a stylistic joy; he merges evolutionary science into speculations on spirituality so that the joins are scarcely perceptible. The reader will find no religious certainties but will recognize a spiritual optimism which shines through, despite recognition of the horrors perpetrated in the name of religion, and finds particular expression in the last few pages.

DJH

Collins Shorter Guide to the Pests, Diseases and Disorders of Garden Plants by **Stefan Bczacki** and **Keith Harris,** with illustrations by **Brian Hargreaves.** Pp. 319, plus 24 coloured plates. Collins. 1983. £9.95.

Collins Guide to the Pess, Diseases and Disorders of Garden Plants published in 1981 (see *Naturalist* **106**: 140), was so successful that a more concise version has been produced, this time with the amateur rather than the professional gardener in mind. The new work retains all the illustrations from the parent work, but the text is 25 per cent shorter, omitting the obscurer pests and diseases that may plague the commercial grower, but which the average garden is highly unlikely to suffer from. It should therefore be easier for the amateur to pinpoint the cause of damage and the cure for it in this invaluable book, which will undoubtedly prove as, or possibly even more, successful than its predecessor.

VAH

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